SCIENCE

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THE STUDY OF THE STARS[1]

THE object of the American Association is the advancement of science. This is a very different matter from the diffusion of human knowledge. The universities and colleges provide liberally for the latter subject, but neglect the former almost entirely. Science is advanced by many individuals who hold offices in the universities, but seldom as a part of their official duties. Few professors are allowed to regard research as a portion of their college work, and still less frequently are appropriations made or funds provided for original investigation. Astronomy is almost the only exception to this rule, and even here in general, the time of the officers is mainly devoted to teaching. Observatories devoted to research like McCormick, Lick and Harvard are supported by funds given specifically for their use, and receive little, or no aid, from the general funds of the universities with which they are associated. It is probable that American universities devote one hundred times as much money to the diffusion of human knowledge, as to its advancement. The great progress made in America in some departments of astronomy is due to the fact that certain wealthy men and women have been willing to give large sums of money for this object. No other country is so fortunate in this respect, although in recent years in Germany large appropriations are being made by the government for similar purposes.

The income of certain funds like the Elizabeth Thompson, Bache and Watson

[1] Address of the President of the American Association for the Advancement of Science, Atlanta, December 29, 1913.

funds is also available, but while these are of the greatest value in aiding particular individuals, the amount is too small to materially advance the entire science. The large funds which might aid individual research are unfortunately employed for other purposes. Scarcely any appropriations have been made to women from these funds. One of the greatest needs of science in America is a fund of moderate size, capable of aiding the men of real genius. The number of such men is not large, and a judicious distribution of a few thousand dollars annually would probably yield greater results than could be obtained in any other way.

A visit to Europe last summer in order to attend the meetings of two national and two international astronomical societies, enabled me to visit several of the larger observatories and to interchange views with the leading astronomers of the world. I have accordingly selected as my subject for this evening "The Study of the Stars," and I shall endeavor to transmit to you the latest views as well as the history of this department of human knowledge. It is my wish to present to my professional friends certain facts of a technical nature, and at the same time to make these clear to those of my hearers who have no previous knowledge of the subject. Astronomy has been called not only the oldest of the sciences but that which has conferred the greatest benefits on man by rendering international commerce possible. While this may be true of the past, the value of the astronomy of the present day lies in its extension of human knowledge and enabling the mind of man to traverse fields which until recently appeared to be hopelessly beyond his ken.

The first catalogue of the stars was made by Hipparchus about B.C. 128, and was inserted by Ptolemy in the "Almagest," for fourteen centuries the authority in astronomy for the world. This catalogue, which contained more than a thousand stars, gave both their positions and brightness. The earliest copy that is known of the "Almagest" is in the Bibliothèque National in Paris. It is a beautiful manuscript in uncial characters of the ninth century. The other later manuscripts unfortunately differ from it and from each other, so that there is some uncertainty regarding two thirds of the stars, owing to errors of copying. A careful study of these discrepancies has been made by Dr. Peters, of Clinton, and Mr. Knobel, of London. Each spent several years on this work, and all the papers are in the hands of Mr. Knobel. He is now preparing the entire work for publication and it is hoped that it will be in the hands of the printer in a few months.

A manuscript of nearly the same age is in the library of the Vatican, and this year a revised edition of it has been published. If we had a correct copy of the original work, it would have a great value at the present time. Half a century ago it would probably have given the best existing values of the proper motions of the stars which it contained, but recent observations enable us to compute their positions in the time of Hipparchus, more accurately than he could observe them, assuming that the motion was rectilinear. This work might, however, throw light on a possible curvature of the motions. The observations by Hipparchus of the light of the stars have a value that will be considered later.

The first accurate measures of the positions of the stars were made in the middle of the eighteenth century. The catalogue of Bradley in 1755 is even at the present time one of the best means of determining the early positions of the stars. A large number of similar, but later, observations by Hornsby are still unpublished. During

the next hundred years the meridian circle, which is at present the standard instrument for determining the places of the stars, was gradually evolved. In this instrument, a telescope is mounted so that it will point only to stars in the meridian, that is, to stars exactly north or south of the observer. The declinations of stars, corresponding to the latitude of points on the surface of the earth, are then measured by a finely graduated circle. Owing to the motion of the earth all stars cross the meridian twice during every twenty-four hours. The right ascension, corresponding to longitude, will be given by the time of transit. At first, this time was found by the "eye and ear" method in which the observer counted the ticks of an accurate timepiece and compared them mentally with the instant at which the star appeared to cross a wire in the field of view of the telescope. About the middle of the nineteenth century a great advance was made by recording the time electrically on a chronograph. This method was known for many years as the "American" method, owing to its introduction and general adoption in this country. This continued to be the standard method almost to the present time, and an enormous number of observations have been accumulated in this way, the total cost amounting to millions of dollars. Perhaps the most valuable work of this kind is that of the Astronomische Gesellschaft, which, by international cooperation, secured accurate observations of the positions of one hundred and sixty-six thousand stars. All stars of the ninth magnitude, and brighter, north of declination $-23°$ are included. Of the twenty zones, seven were observed in Germany, four in the United States, three in Russia, one each in Algeria, Austria, England, Holland, Norway and Sweden. Of the American zones, one was observed at Albany, one at Washington, and two at Cambridge. Each of the latter occupied the time of an observer and several assistants for twenty years. It was expected that these stars would be re-observed after an interval of about fifty years, to determine the proper motions, or annual changes in position. As the time is approaching when this great work should be undertaken, careful consideration should be given to it. Fortunately, the twentieth century has already developed two new methods which might replace the older plans. The first of these is the transit micrometer, in which a motion is given to the wire in the field of the telescope so that it shall follow closely the motion of the image of a star as it transits through the field. A wide difference of opinion exists among leading astronomers as to the best method of securing this motion. In the earlier instruments constructed by Repsold, the motion was given by a screw turned by the two hands alternately. This method certainly gives excellent results and is still used largely in geodetic work. Any one who has tried it will find that with the rapid motion of an equatorial star under a high power it is difficult to satisfy himself that the wire always bisects the star. If clockwork is used, the rate must vary with the declination and it is strange that this is not done by electrical control, instead of the somewhat crude mechanical devices now employed. The wire records its position automatically on a chronograph at short intervals. The plan of permitting this record only when the observer is satisfied that coincidence takes place, as is done at Heidelberg, seems a good one. Evidently a certain relative motion will give better results than a greater or less motion. It would appear to follow logically that this apparent motion should be given to all stars and the record permitted only for the few seconds of apparent coincidence. We can

expect no better results than those obtained with a filar micrometer. The best plan may therefore prove to be to give a motion to the wire nearly equal to that of the star, whatever the declination of the latter, by a suitable variation of the clockwork. The best rate could readily be determined by observing stars at different distances from the Pole. Successive settings should then be made as with a filar micrometer, closing the circuit on the chronograph only when the bisection was satisfactory. A similar setting should also be made for the declinations. The two coordinates could thus be determined with an accuracy substantially the same as that of a filar micrometer. Experience has shown that one star a minute can be observed in both coordinates with the transit micrometer. There can be little doubt that positions could thus be obtained with much greater accuracy than by the methods now in use. The special advantage would be the elimination of systematic errors.

A second method of determining positions, recently developed at the Allegheny Observatory, is by plates taken with a photographic doublet. Ordinary plates must be replaced by those of plate glass. By taking suitable precautions positions may be determined of even the faintest stars, with an accuracy at least equal to that of a meridian circle. To obtain the best results, the field should be about five degrees square on an 8×10 plate. The focal length of the telescope would accordingly be about two meters. The large field would permit the constants of each plate to be derived from stars as bright as the eighth magnitude. The economy of this method would be very great, as compared with a meridian circle. The usefulness of the latter instrument appears to be confined to observations of the brighter stars. Accordingly, its aperture may be reduced. The ideal plan would apparently be to divide the sky into regions five degrees square and select in each, five or more stars of about the eighth magnitude and of approximately the same class of spectrum as Class K, so that all should have about the same color. The positions of these should be determined with the greatest possible accuracy with meridian circles, as described above. Some brighter stars should be included to render available the vast number of observations of these objects made in the past. Positions of the stars in the Gesellschaft Catalogues and all fainter stars should be determined by photography.

Various attempts are now being made to determine the absolute positions of the stars by means of photography. It appears probable that a pier placed under ground will remain free from irregular motions, and that if this can be accomplished, the absolute positions of the stars near the equator can be found by photography. To determine the equinox, Venus and Mercury should be photographed as well as the sun. By the very satisfactory cooperation of the Princeton, Yale and Harvard observatories the position of the moon is now determined by photography. The results of a preliminary discussion indicate an accuracy at least equal to that of the best meridian determinations, those of the Greenwich Observatory.

Excellent progress is also being made in determining the parallax of the stars by photography. The recent increase in accuracy is at least ten fold, or that of another place of decimals. A hundredth of a second of arc can now be determined with greater accuracy than a tenth of a second, twenty or thirty years ago.

The just criticism has been made of American astronomers that while they have contributed more than their share of

the work in astrophysics the older science of astronomy of position has been greatly neglected. This is partly due to the fact that much of this work has been left to the United States Naval Observatory, which in the past has failed to justify the liberal appropriations made for its support. While Congress has given it for many years a much larger income than that of any other observatory in the world, the law has been such that it is impossible to attain the best results. The superintendent must be a naval officer, instead of an astronomer, and even then must go to sea after a short term. Accordingly, the Naval Observatory during a period of 37 years had 20 superintendents with an average term of less than two years. The Greenwich Observatory during a period of 235 years from 1675 to 1910 has had 8 astronomers royal with an average term of 29 years. The work of the latter institution with but half the income has greatly exceeded that of the Naval Observatory. It should be stated, however, that within the last few weeks, the Naval Observatory has established an admirable wireless time service by which any one can obtain, at trifling expense, accurate time within a tenth of a second. The Navy has no need of a great observatory, from which it derives but little credit. Three successive boards of visitors have pointed out the present unfortunate conditions, but the necessary action has not been taken by Congress. The obvious remedy is to remove the observatory to another department, or place it under the direction of the Smithsonian Institution, and appoint an astronomer at its head. What grander field of work could be undertaken by this observatory than that desired by astronomers and neglected elsewhere. For instance, computers of double star orbits are continually complaining that while a surplus of measures of the easy objects are available, many difficult objects are neglected, although measures of them are greatly needed. The same is true of the asteroids, of variable stars, and in fact in almost every department of astronomy. By making the observations desired by experts, every hour would be saved, and work of the greatest value accumulated.

Astrophysics assumed prominence as a science about forty years ago, although it was foreshadowed by certain far-seeing astronomers like the Herschels, G. P. Bond, Huggins, Draper and others. One department, the study of the light of the stars, was developed much earlier, originating in the Almagest and its revision a thousand years later by Sûfi. These catalogues show that the relative brightness of the stars has not changed sensibly during the last two thousand years. Also, that the human eye has the same sensitiveness to different colors, now as then. Stellar brightness was made a precise science by that great astronomer, William Herschel. His six catalogues, two of which remained unknown for eighty years, give precise measures of the light of the three thousand stars contained in them with an accuracy comparable with recent work.

In 1877, stellar photometry was taken up on a large scale at Harvard. Since then, more than two million photometric settings have been made. A station in Arequipa, Peru, permitted the southern stars to be observed on the same system as the northern stars. We have now, accordingly, measures of about eighty thousand stars, including all of the seventh magnitude and brighter, many of the ninth magnitude, and some as faint as the thirteenth magnitude. The excellent work of the Potsdam Observatory gives measures of the light of fourteen thousand stars including all northern stars of the magnitude 7.5, and

brighter. The Potsdam and Harvard systems agree admirably if a correction is applied for the color or spectrum of the stars. They should never be combined, or compared, unless this correction is applied.

Stellar photography, originating in the work of George Bond in 1857, has revolutionized many departments of astronomy. The great work of a chart of the entire sky, undertaken by the Paris Observatory in cooperation with several others, is a sad example of the danger of undertaking a work on too large a scale. Although several observatories have been continually at work upon it for a quarter of a century, it has been predicted that at least fifty years must elapse before it is completed, and no positions of any southern stars have yet been published. In striking contrast to this is the early completion of the Cape Photographic Durchmusterung which gives the positions and magnitudes of nearly half a million stars south of $-19°$. It illustrates the results of the happy combination of skilful planning with routine organization, conducted on a very large scale. The extension of this work to the North Pole is now being planned, but with the additional condition that the color index as well as the photographic magnitude will be determined. The former will be found by photographing the stars by means of their yellow or red, as well as with their blue, light, the difference in the magnitudes giving the color index. Much might be said of the numerous applications of photography to the determination of stellar magnitude. The sixty-inch reflector of the Mount Wilson Observatory, using exposures of several hours, has succeeded in photographing stars as faint as the twentieth magnitude. An international committee, with members from England, France, Germany, Russia, Holland and the United States, has adopted a scale of magnitudes based on two investigations made at Harvard. One of these was made with the meridian photometer, and the other is an elaborate investigation by Miss H. S. Leavitt of the photographic magnitude of seventy-six stars near the North Pole. A standard scale is thus provided from the first to the twentieth magnitude. We may say from the minus twenty-sixth to the twentieth magnitudes since accordant results for the light of the sun have been obtained by Professors W. H. Pickering and E. S. King. For many purposes, photography may well replace visual photometric measures, since for stars brighter than the fifteenth magnitude photographs may be taken with yellow light. One of the principal uses of measures of the light of the stars is the study of the variables, or those in which the brightness is not constant. A bibliography of these by Miss Cannon is recorded on about forty thousand cards. The number of known variables is now about forty-five hundred, of which three quarters have been discovered by photography, at the Harvard Observatory. There are several kinds of variable stars. Variables of long period undergo changes which repeat themselves somewhat irregularly in a period of several months, and at maximum are often several thousand times as bright as at minimum. The most useful work that an amateur can do with a small telescope is the observation of these objects. An important work undertaken by the British Astronomical Association has been the observation of variable stars. During the last thirteen years they have accumulated twenty thousand such observations, all reduced to the same scale, which is that of the Harvard Photometry. Similar work in this country has accumulated ten and sixteen thousand observa-

tions in the last two years, respectively. Variables of short period complete their changes in a few days, or hours. Professor Bailey has found five hundred such objects in the globular clusters. In one of these clusters, Messier 3, out of a thousand stars one seventh are variable, all have a period of about half a day, and their periods are known within a fraction of a second. Their light changes so rapidly that in one case it doubles in seven minutes. It is a strange thought that out of a thousand stars, looking exactly alike, there should be a hundred little chronometers keeping perfect time, and whose rate is known with such accuracy. About a hundred and fifty variables belong to the Algol class, in which the light is uniform for a large part of the time, undergoing a sudden diminution at regular intervals. This is due to the eclipse of two bodies, one darker than the other, revolving around their common center of gravity. An elaborate theoretical study of this problem has been made at the Princeton Observatory and, largely from the photometric and photographic magnitudes made at Harvard and elsewhere, the dimensions of a large number of these systems have been determined.

Photography still can scarcely compete with other methods where the greatest accuracy is desired, as for instance, the measures with the polarizing photometer by the late Oliver C. Wendell. The masterly use of the selenium photometer by Professor Stebbins gives results for bright stars of still greater accuracy, while the experiments in Germany with the photo-electric cell by Rosenberg and Guthnick give results which promise to revolutionize our present methods. The principal source of error appears to be the varying transparency of the air. The trial of the instrument in a location where the air is exceedingly clear and steady for long periods is greatly to be desired.

During the last twenty-five years photographs have been obtained by the Harvard Observatory in order to furnish a history of the stellar universe. Two similar 8-inch photographic doublets have been used, one mounted at Cambridge for the northern, and the other at Arequipa for the southern stars. With each of these instruments about forty thousand photographs have been taken. The total weight of these plates is about forty tons. As each plate covers a region ten degrees square, every part of the sky has been photographed, on the average, a hundred times. This work is now supplemented by two small Cooke anastigmat lenses, each having a field thirty degrees square. The number of plates taken with these two instruments are nine thousand and fourteen thousand, respectively. The exposures with the larger instruments are, in general, ten minutes, showing stars of the thirteenth magnitude. The exposures with the smaller instruments are one hour, showing stars of the eleventh magnitude. A continuous history of the sky is thus furnished from which the magnitude and position of any stellar object of sufficient brightness can be determined for a large number of nights during the last quarter of a century. A striking illustration of the value of this collection occurred when the planet Eros was discovered in 1898. It appeared that this object was nearer the earth in 1894 than would occur again for thirty-five years. An examination of the photographs showed its presence on 23 plates, and from their positions the parallax of the sun and mass of the earth were determined with an accuracy equal to that of any of the methods previously used, and on which an

enormous amount of time and money had been spent.

For many years the Kiel and Harvard observatories have served as distributing centers of astronomical discoveries and observations in Europe and America, respectively. The last new star which is known to have appeared, Nova Geminorum, No. 2, was discovered by Enebo at Dombass, Norway, on Tuesday, March 13, 1912. The cable message was received at Cambridge Wednesday morning, and the star was observed at several American observatories the next evening, or the night following its discovery. An examination of the Harvard photographs showed that two plates had been taken on the preceding Sunday, March 11, on which no trace of the Nova was visible, and two on Monday, March 12, showing it of nearly its full brightness. Photographs taken Wednesday compared with those obtained a few days later showed the wonderful change in its spectrum, from the solar type with dark lines, to the typical spectrum of a Nova with bright lines.

There is no department of astronomy which is now receiving greater attention than the study of the spectra of the stars. Dr. Henry Draper was the first to photograph the lines in a stellar spectrum, although Sir Williams Huggins had already obtained a mark from the spectrum of Sirius, and later was the first to publish his results in successfully photographing stellar spectra. The untimely death of Dr. Draper, in the midst of his work, led to the establishment at Harvard of the Henry Draper Memorial. For nearly thirty years Mrs. Draper has maintained an active interest in this work. By placing a large prism over the objective of a telescope, the light of all the brighter stars in the field are spread out into spectra, so that instead of photographing the spectrum of one star at a time, as with a slit spectroscope, as many as a thousand have sometimes been taken on a single plate. Such photographs, covering the entire sky, have been taken with the two 8-inch doublets already mentioned. A study of the spectra thus obtained enabled Mrs. Fleming to discover many hundred objects whose spectra are peculiar. Among them may be mentioned 10 of the 19 new stars known to have appeared during the years in which she was engaged in this work, while five of the others were also found at Harvard by other observers. She discovered more than two hundred variable stars, 91 out of the 108 stars of the very peculiar fifth type, and showed that these objects occurred only very near the central line of the Milky Way. During the last two or three years a great demand has arisen for the class of spectrum of large numbers of stars. The Harvard photographs show the class of spectrum of nearly two hundred thousand stars. Miss Cannon has, accordingly, undertaken to prepare a catalogue of these objects, with the result that she has already classified about one hundred and fifteen thousand spectra, covering more than one half of the sky. The work is progressing at the rate of five thousand stars monthly, and the results will fill seven of the large quarto *Annals* of the Harvard Observatory. The organization of this work has required the most careful application of the principles of "scientific management."

One of the most important results derived from the Harvard photographs was the discovery that in certain spectra the lines were alternately double and single. This, and the discovery by Vogel at Potsdam that the lines of the variable star Algol continually changed their position revealed the existence of spectroscopic binaries. No department of astronomy is

receiving more attention, at the present time, than these objects, and in general the motion of the stars in the line of sight. The Lick, Yerkes, Greenwich, Potsdam, Bonn and Ottawa observatories are only a portion of those directing a large part of their energy to this subject.

One of the most important generalizations of recent times is the discovery by Professor Campbell that the velocity of a star depends upon its class of spectrum. The proper motion of a star was similarly found by the late Lewis Boss to be dependent on the same quantity.

In conclusion, the United States has attained an enviable position in the newer departments of astronomy. Can this be maintained? In Europe, especially in Germany, observatories and instruments of the highest grade are now being constructed, the government furnishing appliances with the most liberal hand. Perhaps the most promising sign for the future is the friendly cooperation of American astronomers, which has never been more marked than at the present time.

The possibilities of work are now greater than ever before. A small fraction of the effort expended in teaching science if devoted to its extension and progress would fulfil the objects of the American Association for the Advancement of Science.

EDWARD C. PICKERING

PROGRESS OF THE CHEMISTRY OF AGRICULTURE[1]

IT is the object of this address to present briefly the important recent advances made in agricultural chemistry. In so doing, it is not my intention to go back one hundred years or fifty years or even to the period included in the memory of the veterans of this association; but only to consider such a period as is within the memory and the experience of a youngster like myself.

Agricultural chemistry is so closely interwoven with the other sciences which have been applied to agriculture, that it is practically impossible to disentangle them. Hence, to a certain extent, the progress of the chemistry of agriculture is closely related to the progress of other agricultural sciences, and to agricultural science, in general. The contributions of the chemist to agricultural science have been so many, so varied and so important, that for a long time the sciences applied to agriculture have been termed agricultural chemistry. This period is passing, and the term agricultural chemistry is being more restricted in its significance, but the field is still broad, and the harvest bountiful to the worker who seeks to garner the grain of knowledge.

There has been a tendency in some colleges to discontinue the teaching of agricultural chemistry, and to divide the subject-matter between the agronomist and the animal husbandman. It is a serious question whether such tendency is in accord with the known laws of specialization in science. There is no doubt but that, as time goes on, the agricultural chemist must specialize more and more in one of these fields of work, but there is a difference between the specialization of the scientist in his own field, and the attempt of other branches of agricultural science to take over the work of the chemist, or the chemist to take over other branches of agricultural science. As I see it, both the agronomist and the animal husbandman have their special problems. They must have their special training in their own fields, and while this training must include some chemistry, it is not sufficient in quantity to

[1] Presidential address before the Association of Official Agricultural Chemists of North America (November 18, 1913).

make them into chemists in addition. On the other hand, the chemist must be, first of all, a chemist. The agricultural chemist must have knowledge of soils and animal nutrition, but he should have predominant chemical training and chemical methods of thought. The agronomist and the animal husbandman undoubtedly need the aid of the chemist in the solution of their problems; but they should not seek, at one and the same time, to be both agronomist and chemist. The result of such an effort is either an agronomical chemist or a chemical agronomist. It often results in the chemist becoming also the agronomist. What agricultural science needs is the highly-trained agronomist, working, where needs be, in cooperation with a highly-trained chemist who has perhaps specialized in soils and fertilizer chemistry, each assisting and aiding the other. The same is true of the animal husbandman. We need the animal husbandman, highly trained in his field and with a full knowledge of its peculiar problems, working in cooperation with the agricultural chemist, highly specialized in the chemistry of animal nutrition. In this way, we shall avoid those errors which we so often see when a man enters into a field outside of his special training—errors which the specialist immediately recognizes. The truth of the matter is, that the chemist has made such great contributions to the field of agricultural science, that the agronomist and the animal husbandman have, in many cases, not been able to see their own peculiar problems, but have emphasized the chemical side of the subject. They have not wholly found themselves. In some institutions, agricultural chemistry is no longer taught. This, we believe, is a mistake. The student needs a thorough grounding in the entire field, such as is given by the agricultural chemist, and he needs to look at agriculture, for a time, from the point of view of the chemist. Specialization should come later.

These matters will adjust themselves in time. We need not fear that the science of agriculture will ever be without the need of the agricultural chemist. Our ranks have not thinned, but each step of progress has rather added to our numbers. The Adams Act, for example, which is one of the most important events in the recent history of agricultural science, has increased the number of agricultural chemists, as well as the number of other agricultural investigators.

The Adams Act, of March 16, 1906, is important, not only from the fact that it increased the number of scientific agricultural workers in the experiment stations, and their facilities for investigation, but because it affords to the experiment stations opportunity for fundamental research work. The passage of the Adams Act indeed marked an epoch in the history of agricultural science. The experiment stations had previously done much valuable work, and accumulated much data, a fact which the passage of the Adams Act itself recognizes. But the experiment stations had such large demands upon them for immediate and practical information, that they had little time for the investigation of fundamental things, no less practical in their final application, but requiring more time, more patience and less obvious in their practical applications. But under the Adams Act, the experiment stations not only may, but must, conduct research. Fundamental and continuous work may be done upon projects which have no present popular appeal, though no one can predict the ultimate effect of such work. The result of the Adams Act has been an increase in personnel and in facilities for the experiment stations, and it has aided in

creating a demand for more highly trained research assistants. It has also tended to raise the standard of scientific publications of the stations. Thus, as I said, with the passage of the Adams Act, the experiment stations entered upon a new period of their existence, one in which fundamental research becomes a much greater portion of their functions than has been the case in the past. It is true that some directors of stations, and some governing boards, do not yet understand the true significance of research, or the qualifications necessary to pursue it. It is true that some station men do not, in their publications, give proper references to previous work, which may have anticipated their own. It is true that in bulletins and in reports of directors, we sometimes find claims of credit for work which are exaggerated, or perhaps the credit belongs elsewhere; claims which are hardly pardonable, even after making all possible allowance for natural exaggerated opinions of one's own work. Such things will pass away. We need more criticism of our agricultural publications—not destructive criticism, but friendly criticism, and friendly controversies over disputed points. Criticism of the proper kind is a stimulant to good work, and aids in pruning away excrescences such as those mentioned above.

The Adams Act created a demand for men capable of research in agricultural chemistry, and other lines of agricultural science. Research is not an ordinary qualification, even in young men just graduated from college. The ability to do research work must be founded upon a natural ability and inclination towards such work, developed by broad general training, and wide knowledge of some particular science, and by an apprenticeship under one who is himself a master of research. This apprenticeship may be during a course of work and study for the degree of Doctor of Philosophy; but it may also be in the process of regular station work under some eminent station investigator. We must recognize the fact that all men capable of research have not been able to secure the Doctor's degree, even though they have done equivalent work. The ability to do research work may be developed by study and training, but it can not be created.

The Adams Act thus marks an important step in the progress of agricultural chemistry, other agricultural sciences and agriculture, as a whole. Perhaps equally as significant was the passage of the National Food and Drugs Act, approved June 30, 1906. Taken in a broad way, the passage of this act was one of a series of events in the reaction of the people against dishonest commercial practises. It has become evident that the people will no longer tolerate practises which have crept into use, which are morally wrong, but were formerly considered as all right because they were business; practises which deceive the buyer or give unfair advantages in business competition. Business has been a species of warfare, but just as it is now contrary to the laws of civilized warfare to kill women and children and burn private dwellings, so it is becoming contrary to the laws of business warfare to cheat women and children and to deceive the purchaser as far as possible. How much the agitation for the pure food and drug law had to do with this moral awakening, no one can say, but no doubt this crusade of twenty-two years had much to do with it—a crusade by an agricultural chemist, Dr. Harvey W. Wiley, for many years chief of the Bureau of Chemistry; secretary of the Association of Official Chemists from its organization until only a little more than a year ago, now our hon-

orary president—for whom all of us have a warm place in our hearts.

The Food and Drugs Act has resulted in a material clearing of the atmosphere, with respect to the naming, labeling and adulteration of foods, drugs and feeds. We now have very clearly defined the objects of such a law. These are, first, to prevent the sale of any unwholesome or deleterious substance, and second, to ensure that the goods delivered to the purchaser shall be exactly as represented. These principles have been made clear, not only with respect to foods and drugs, but also with respect to feeds, and feed manufacturers are beginning to realize that a mixture of bran and screenings may no longer be sold as bran, or a mixture of corn bran and corn chops, sold as corn chops. There are some feed manufacturers who have not yet read aright the signs of the times, as, for example, some of the manufacturers of cottonseed meal, who contend for the authority to sell a mixture of meal and hulls under the name of cottonseed meal, but undoubtedly the time will come when this matter will be made clear.

This association has played an important part with respect to food adulteration. Before 1900, there was one referee and one associate on this subject. At the 1900 meeting, provision was made for 14 associate referees, and there are now 21 associate referees. In addition, we have our committee on food standards, which has done valuable work.

In the matter of cattle feeds, their analysis and adulteration, it appears this association has done little in recent years. The analysis and control of these feeds are yearly assuming a greater importance. There should be a referee and an associate referee on the adulteration of feeds and methods for their detection. We have no official methods on this phase of the subject, beyond the ordinary analysis. The method for crude fiber should be thoroughly studied, and perhaps modified. The clause which permits filtration through cloth should be eliminated. The estimation of crude fiber is becoming more and more important, for by its use we can detect more easily the addition of materials rich in crude fiber, to concentrated feeds. The estimation of crude fiber, for example, shows much more clearly the probable quantity of cottonseed hulls in cottonseed meal, or rice hulls in rice bran, than does any estimation of protein and fat.

Striking progress has been made in recent years in the study of soils. This applies especially to the survey and mapping of soils. In this work, the Bureau of Soils is easily the leader. There is a tendency in some quarters to regard the survey, mapping and analysis of soils as an end in itself. It is true that such work is highly important, but it should also be regarded as a basis on which to make further soil investigations so that we may become fully familiar with the properties and characteristics of each type. In a sense, the soil survey should be regarded as the beginning of soil studies.

In other respects our knowledge of soils has been increased by recent investigations. We now know more concerning the nature and constituents of the organic matter of the soil, and something more concerning its biological properties. We also know that, on an average, the needs of the soil for fertilizer nitrogen in pot experiments is related to the total nitrogen of the soil. We know that the active potash of the soil is related to the average needs of the soil for potash in pot experiments, and that plants have the power to exhaust the active potash and to take up more potash than they need. We know that, on an average, the active phosphoric acid of the soil is re-

lated to the needs of the soil for phosphoric acid in pot experiments. The relation of the pot experiments, and the analysis, to field needs, must be worked out. Soils also deviate from the average, as regards their plant food content and behavior to pot experiments; such deviations must be studied and their causes ascertained. There is much to be done, but progress is being made.

In the field of animal chemistry, decided progress has been made in recent years. We must now recognize the possibility, that, in digestion, proteids of different kinds may be split into different products, some of which may be unfit for use as structural material in building up animal proteids, and so must be discarded. We know that this is possible, but we have not yet secured positive evidence that such occurs with any of the various proteids fed domestic animals. Such studies may be expected in the future.

It has been shown, without doubt, that the digested materials of different feeds have different values to the animals. One pound of digestible nitrogen-free extract in corn has a much greater value than one pound of digestible nitrogen-free extract in straw. The fact that there is a difference in the values of digested nutrients of the same class but from different feeds has been clearly shown by the work of Kellner and of Armsby. There is no doubt about it. It is a step forward to recognize the differences in the values of the digested nutrients and to adjust our tables, our rations and our calculations accordingly. There is abundant room for work along this line, but enough work has already been done to justify this advance. Nearly every American book which deals with the feeding of animals still assumes that the digestible nutrients of one feed are equal in nutritive value, pound for pound, to the digestible nutrients of the same class in any other feed. These books must be re-written and adjusted to our latest advances in knowledge. This advance will, to a certain extent, reconcile the differences between the effects of feeds or of rations in feeding experiments which, under the old standards, should have apparently the same nutritive values.

We are now able to state the nutritive value of a feed in terms of three factors: its bulk, which satisfies the hunger of the animal; its proteids, which repair flesh or tissue, or which, in excess, may be used for fat or energy; its fat-producing value, which is its ability to furnish the animal with heat or energy or to form fat. The fat-producing value of a feed or nutrient is determined experimentally. First, the fattening animal is fed a ration which produces a slight gain of fat, and the gain of fat is measured by determining the income and outgo of carbon and nitrogen. Next, the nutrient or feed is added to this ration, and the gain in fat again determined. The difference in the quantity of fat produced is due to the added feed or nutrient.

The results of such work can be readily compared with calculations based on the assumed equality of the same group of nutrients in different feeds. While the calculated value of peanut meal or linseed meal is practically equal to that found, the value for a wheat straw is only 20 per cent. of that calculated, of meadow hay 54 per cent., of rye bran 79 per cent. of that calculated.

It should be clear that the recent advances in the chemistry of animal nutrition compel us to modify materially tables of feeding values, rations, and methods of calculation. There is opportunity for useful and valuable work along the lines of determining exactly the productive values

of feeds and nutrients, and such work may be expected in the future.

In the thirteen years of the twentieth century the progress of agricultural chemistry has been such as to satisfy even the pessimist that we are moving forward. Our facilities for scientific investigation have been increased by the Adams Act. Our supervision over foods, drugs and feeds has been enlarged and rendered more effective through the Federal Food and Drugs Act. We have made great progress in the survey and mapping of soils and in our knowledge of their properties and chemical composition. The science of animal nutrition has made such advances as to render it necessary to revise almost all books dealing with the subject, and to modify our methods of stating the nutritive values of feeds, and our methods of calculating rations for feeding animals. These have been the four chief lines of advance of agricultural chemistry in recent years. The members of the Association of Official Agricultural Chemists may well take pride in the part they have taken in the progress that has been made.

G. S. Fraps

THE NEW YORK STATE VETERINARY COLLEGE AT CORNELL UNIVERSITY

This occasion[1] is to commemorate the opening of a suitable hospital for large and small animals and halls for the teaching of veterinary medicine. It has greater significance than the mere addition of new buildings to our working equipment, for it introduces into the teaching of clinical medicine methods of precision which heretofore could not be employed. We believe it is desirable that the public should know what the university and the state are doing to increase the efficiency of the veterinary profession.

In the development of veterinary medicine in America, Cornell University holds a conspicuous place. It was the first institution of higher learning to place veterinary medicine on par with other sciences. When its doors opened in 1868, there was among its professors a veterinarian. A department of veterinary medicine was established and it continued as such until 1896. During those twenty-eight years, the head of that department, our distinguished and beloved Dr. Law, was not only an adviser in university affairs, but also a leader in the important work of the nation in eradicating those diseases of cattle that cost Great Britain and her colonies hundreds of millions of dollars. Had it not been for the broad views of Ezra Cornell and President White relative to the teaching of applied sciences in Cornell University, where Daniel E. Salmon, Theobald Smith and Leonard Pearson were trained, the losses on British soil from contagious pleuropneumonia, piroplasmoses and foot and mouth disease might easily have been duplicated in this country.

At the time the department of veterinary science was organized in the university, it was not thought in this country to be necessary to expend large sums of money for veterinary education. The American people experienced with the resignation of the fatalist a steadily increasing loss from diseases of animals. Because of the enormous live stock industry and export trade in cattle and animal products, this loss was not generally felt. The time was approaching, however, when our meat and dairy products would be required to feed our own people and when the losses sustained from disease would be added to the cost of living. This condition was as inevitable here as it had been in Great Brit-

[1] Opening of hospital and clinic buildings, New York State Veterinary College at Cornell University, November 15, 1913.

ain and Germany. It was with prophetic insight that the founders of this institution planned to meet the needs of the approaching situation. It was clear to them that when the law of supply and demand raised the price of meat to a certain height it would be necessary to save the thousands of animals that were annually falling victims of preventable disease. In recognition of this, veterinary teaching at the university began in a small way, but from the beginning its growth was assured.

A second advance was made when the university and the state formed a partnership in which the university was to give toward a veterinary curriculum such instruction as it possessed and the state was to furnish the other necessary teachers, buildings and equipment to complete a veterinary college. By this act, the veterinary department was transformed into a college and a greater work was undertaken. The statute establishing the New York State Veterinary College at Cornell University states that its function shall be the pursuit of such researches and the preparation of such diagnostic and prophylactic agents as may be necessary to protect our domesticated animals against disease and to give instruction in veterinary medicine and surgery. The framers of that law saw with great clearness that the live stock interests of the state required for the control of disease men with a thorough training in the sciences upon which the art of medicine rests. They recognized that the high purpose of the veterinary profession was to prevent quite as much as to treat diseases of animals. This required that students of veterinary medicine should have a preliminary education sufficient to intelligently study those sciences which have revealed the nature of disease. To provide for this, the law requires that in order to enter a veterinary college in this state, the student shall have satisfactorily completed a four-year high school course or its equivalent. This was a long step in advance educationally, although many considered such a preparation unnecessary. There seemed to be a feeling that the successful practise of veterinary medicine in this country did not require the knowledge or discipline that experience had demonstrated as necessary for its success in Europe. However, the great champion of higher veterinary education in this country firmly insisted on the higher entrance requirements. For his perseverance in this cause alone, future generations will look upon Dr. Law as the foremost veterinary educator in America.

This college opened in 1896 with the main building, one story of the north wing and a small clinic building and hospital. These cost the state $150,000. For reasons mentioned, the number of students was small, a total of eleven, and the faculty consisted of eight teachers. For several years, there were no additional buildings and the students increased in number very slowly. The principle of higher veterinary education was on trial. Finally growth was in evidence. The Flower library was endowed with $10,000. An operating room was built on the surgical hospital and the second story of the north wing was added. These cost $27,050. In 1908, the trustees of the university set aside for the veterinary college a farm of one hundred acres for use in the study of animal diseases. And finally, there has just been completed, but not equipped, the hospital for large and small animals and clinic halls for teaching veterinary medicine. These have cost $140,000. The state has a total of $317,050 invested in buildings and $54,000 in equipment. The college, however, is not yet completed. There remain to be added the south wing to the main building and a

diagnosis and pathological laboratory. It is estimated that they will cost $200,000. While these appropriations may seem large, it is well to know that the little country of Norway, with far less live stock than the Empire State, has recently built a national veterinary college at a cost of 2,300,000 krona ($644,000) or a hundred thousand dollars more than the plans of this college call for.

The completion of suitable hospitals for large and small animals, clinic halls and diagnostic laboratories adapted to the teaching of clinical medicine justifies our calling this the beginning of the third era in the development of veterinary medicine at Cornell University. The opening of these splendid wards is significant not only from the pedagogic point of view but also from the standpoint of better veterinary service in the state. The thought of the leading educators in human medicine has been that the teachers of medicine should have adequate hospital facilities to study disease in all of its phases and that they should not be distracted by private practise. This ideal toward which our best medical colleges have been striving has been attained in but few institutions. In this particular, we are fortunate. With ample hospital and clinical facilities and men eminently fitted for teaching veterinary medicine, it is confidently expected that greater efficiency will not only characterize the teaching of students but also increase the application of better methods for the treatment, prevention and control of animal diseases in the state. In rejoicing that such opportunities have been provided, we must not be boastful, for in the acquisition of such facilities, the states of Iowa, Ohio and Pennsylvania have led the Empire State. We do rejoice, however, that America is beginning to realize that if the fearful losses from animal diseases are to be checked here as they are in Europe, veterinary medicine must be taught and practised along equally scientific lines.

The work of the veterinarian is not generally understood or appreciated. It is not the only purpose of a veterinary college to teach men how to treat the accidental ills of animals. In addition to this, the veterinarian has to advise the owners how to protect their flocks and herds from the diseases which are liable to attack them. In New York state there are $290,000,000 invested in animals. The annual revenue from this investment is $140,000,000 or nearly two fifths of the total agricultural product of the state. It has been conservatively estimated that the loss from disease is ten per cent. One of the problems for the veterinarian is to save to the live stock industry all that is preventable of the $29,000,000 loss on investment and to restore as much as possible of the loss in production due to disease. The control of the diseases of animals communicable to man is not a task of small proportions. The inspection of dairy cattle to detect and eliminate those whose milk is dangerous, to inspect the meat from diseased animals that are killed for food, and the many other services of a sanitary, humane or economic significance require a large fund of technical knowledge. It is not my desire to dwell upon the multitude of needed services the trained veterinarian can render but rather to call attention to the efforts that are being made to qualify men for such work.

I have already mentioned the purpose of the founders of this college and the somewhat discouraging outlook at its opening. Starting with an initial enrollment of eleven students in all classes and a faculty of eight, we have now a registration of one hundred and twenty-three undergraduate students and five graduates and a faculty of nine-

teen men who devote their entire time to teaching and research. Knowing that the state would not require a large number of veterinary graduates in any one year, the college was planned, as you can see from your inspection, to teach from fifty to seventy-five students in each class. This is all the veterinarians that the live stock interests of the state will require for many years.

The general tendency toward increased efficiency has been exemplified in this college by the adoption of certain procedures to extend its usefulness. An optional four-year course has been offered and several students are taking it. This was done to make it possible for those who desire to devote more time to their preparation for professional work. We hope in the near future to make the four-year course compulsory. There is a difference of opinion on this point. It is thought by some that it would be better to have one year of university work required for entrance than to have a four-year professional course with the present lower entrance requirements.

A combined course with the college of agriculture has been arranged so that students may receive both degrees in six years. A few students are already taking this course.

The ambulatory clinic was established to enable senior students to visit with an instructor sick animals in the near vicinity of the college. This gives a touch of actual practise in connection with class-room and laboratory work.

In 1908 there was established an annual conference for veterinarians. The faculty appreciated its opportunity to assist the practitioners of the state by introducing a short course of instruction on the most important veterinary subjects of the day. Every licensed veterinarian of the state is invited. Last year fully 15 per cent. of the active practitioners of the state attended this conference.

In June of this year a course in practical horseshoeing for the horseshoers of the state was authorized. This is under the immediate supervision of an experienced horseshoer who was trained in the leading schools of Europe.

The research work that is being done at the veterinary experiment station as well as in the laboratories is not only of great value to the live stock owners of the state and of much teaching significance, but it also brings the students in contact with the actual problems with which the practitioner has to deal in the active warfare against disease. It is by these and other methods that the New York State Veterinary College at Cornell University is striving to be a positive factor in alleviating the suffering among domesticated animals and in saving to the owners the losses from disease.

VERANUS A. MOORE

STEREOSCOPIC EFFECTS IN PHOTOGRAPHY

THE exhibition of scientific photography which was recently held at Vienna in connection with the Austro-German Medical Congress contains, according to an article in the London *Times*, an exhibit which marks a great advance in the progress of photography. This is a series of photographs in which true plastic effect is obtained without the employment of a stereoscope or any other optical instrument. For the various objects depicted to stand out in their true relations to one another all that is required is that the picture should be looked at directly and not from one side or the other.

The method by which this result is obtained is, briefly, as follows: A double negative is made in the ordinary way by the use of a stereoscopic camera with twin lenses. Instead of the reconstruction by means of the stereoscope of the plastic image from the

pictures thus obtained the inventors, Herr Friedmann and Herr Reiffenstein, have devised another means of making each eye see only one, and that one its own particular image. This consists of the application of the fact that when placed against a white background the image on a positive transparency is visible and that when seen against a black background it becomes invisible, while should the image be bleached the contrary is the case. From the negatives which have been obtained in the ordinary way with the stereoscopic camera are made, therefore, from one, an ordinary transparent positive, and, from the other, a negative which is afterwards bleached. Let it be assumed that from the negative corresponding to the image seen with the right eye the ordinary positive is made and that the left eye's picture becomes the bleached negative. If these two transparencies were super-imposed one upon the other and laid upon a white background only the right-eye picture would be visible. On the other hand, if placed upon a black background only the left-eye picture would be seen. It is, however, necessary that both eyes should see their respective pictures simultaneously. For this a background is required which to the right eye appears white and to the left eye black. This is provided by a sheet of glass, the back surface of which is prepared in a special manner, while the front surface is ribbed convexly, whereby the rays of light falling upon this surface are broken in such a way as to make it appear black or white according as looked at from one side or the other. The problem is, therefore, solved. The two transparencies are placed one upon the other and then both upon this background. The right eye sees only its proper image and the left eye likewise. These combine automatically, as is the case when a stereoscope is used, and the result is a true plastic picture.

The inventors exhibit five or six specimens of such photographs to which they have given the name of "stereographs." Three of these appeared to the writer of this article to be almost faultless. One of them represented a lump of quartz in which even the shimmer on the surface was reproduced; another, a spray of orchids in a vase, and the third, the skeleton of a gorilla. In the other specimens the two images did not seem to combine easily. The inventors are making arrangements for the manufacture in cheap and handy form of "backgrounds" which they hope before long to have brought to such a state of perfection that the process will be generally employed. With such "backgrounds" the inventors state that pictures can be looked at like any other photograph. In the case of the stereographs now being exhibited the effect of the black-and-white background is, however, obtained by a different method, which necessitates their being viewed by transmitted light.

SCIENTIFIC NOTES AND NEWS

The sixty-fifth meeting of the American Association for the Advancement of Science opened at Atlanta on Monday, Dr. Edmund B. Wilson, of Columbia University, being introduced as president, and Professor Edward C. Pickering, of Harvard University, giving the address of the retiring president on "The Study of the Stars," printed in this issue of Science. Subsequent issues will contain other addresses and reports of the meetings at Atlanta and of the meetings held simultaneously at Philadelphia, Princeton, New York and New Haven.

M. Jean Perrin, professor of physical chemistry of the University of Paris, has been given the degree of doctor of science by Columbia University, to which he is this year visiting professor.

Sir Philip Watts, K.C.B., F.R.S., has received the Order of the Rising Sun (second class) from the Emperor of Japan.

Dr. Charles DeGarmo, since 1898 professor of the science and art of education at Cornell University, will retire at the close of the next summer session.

The Senate of the University of St. Andrews has invited Professor J. Arthur Thom-

son, since 1899 regius professor of natural history at Aberdeen, to be the Gifford lecturer for the years 1914 to 1916.

MRS. ELLA FLAGG YOUNG has been reinstated as superintendent of schools by the Chicago Board of Education by a vote of thirteen to seven, the minority of seven declining to cast a ballot.

DR. KEIVIN BURNS, of the Lick Observatory, has been appointed to a post in the Bureau of Standards, Washington.

THE Royal Society's studentship on the foundation of the late Professor Tyndall for scientific research on subjects tending to improve the conditions to which miners are subject has been awarded for the ensuing year to Mr. J. I. Graham, of Bentley Colliery, Doncaster, for an investigation into the cause of spontaneous combustion of coal.

DR. LYMAN C. NEWELL, professor of Chemistry, Boston University, has been elected president of the University Club of Malden, Mass.

AT the educational conference, held at the University of London, beginning on December 26, twenty-one institutions were represented. Mr. James Bryce delivered the inaugural address, entitled "Salient Educational Issues."

"SCENIC Features of North America from the Geological Point of View" is the general subject of a series of illustrated lectures to be given by Professor Wallace W. Atwood, of the department of geology of the University of Chicago, at the West Side center of the University Lecture Association in Chicago. The series begins on January 3 and ends January 31, one lecture being given each week.

THE following public lectures are announced by the Cornell Chapter of the Sigma Xi: "Recent Investigations in Organic Chemistry," by Professor A. W. Browne, January 19; "Electric Operation of Panama Canal Locks," by John W. Upp, M.E., '89, of the General Electric Company, February 3; "Some General Bearings of Embryology," by Professor B. F. Kingsbury, February 23; "Electric Waves and Wireless Telegraphy," by Professor Ernest Merritt, March 30; "The Experimental Development of the Art of Sewage Disposal," by Professor H. N. Ogden, April 30; "Some Recent Problems in Geometry," by Professor Virgil Snyder, May 25.

ON November 20, Professor M. A. Rosanoff, of Clark University, gave a talk before the Sigma Xi Society at the Worcester Polytechnic Institute on his scientific experiences at the *Versammlung deutscher Naturforscher* in Vienna last September.

MR. EMERY C. KOLB, of Grand Canyon, Arizona, gave a lecture, illustrated with colored slides and motion pictures, before the Geographic Society of Chicago on December 19, the title being "Photographic Exploration of the Canyons of the Colorado River."

DR. STUART PATON will give a series of public lectures at Princeton University on Thursday afternoons at five o'clock on The Study of Human Activities in Relation to Social, Educational and Ethical Problems. The dates and subjects are as follows: February 12, "The Individual. Life as a Process of Adjustment"; February 19, "Adjustments in the Reflex, Automatic and Conscious Levels of Activity"; February 26, "Synthetic and Inhibitory Mechanisms"; March 12, "The Personality"; March 19, "The Problem of Degeneracy. The Feeble-minded, the Delinquent, the Criminal"; March 26, "The Intelligent Direction of Human Activities. Education"; April 2, "Science and Culture."

AT the annual public meeting of the Paris Academy of Sciences, held on December 15, M. Gaston Darboux, the permanent secretary, pronounced a eulogy on Henri Poincaré, the famous mathematician, who died in July last year. The speech included an account of Henri Poincaré's early life.

IT is proposed to establish a permanent memorial to the late Sir William White, K.C.B., F.R.S. The Institution of Civil Engineers, the Institution of Mechanical Engineers, and the Institute of Marine Engineers, and other bodies are supporting the plan, and

have invited their members to contribute. A general committee under the chairmanship of Lord Brassey has been formed. The form which the memorial is to take will depend upon the support which is given, about $7,500 having already been received.

Dr. Charles Budd Robinson, economic botanist of the Bureau of Science of the Philippine Islands has been killed by natives in the Amboyna Islands in the Malay Archipelago. Dr. Robinson was born in Pictou, N. S., in 1871; he received his bachelor's degree from Dalhousie University in 1891 and his doctor's degree from Columbia University in 1906. He was the author of researches on the economic and systematic botany of the Philippines.

The death is announced in London on December 15, of Dr. Penry Vaughan Bevan, professor of physical science at the Royal Holloway College.

The U. S. Civil Service Commission announces an examination for technical assistant in pharmacology, for men only, to fill vacancies in this position in the Division of Pharmacology, Hygienic Laboratory, Public Health Service, at salaries ranging from $1,800 to $2,000 a year.

The next grants from the Elizabeth Thompson Science Fund will be made in February, 1914. Applications should be sent in to the secretary, Dr. Charles S. Minot, Harvard Medical School, Boston, Mass., before February 1, 1914.

The Edward N. Gibbs Memorial Prize Fund, the income of which amounts to about five hundred dollars, was established by the wife and daughter of the late Edward N. Gibbs, and is used in aiding investigators into the cause and treatment of diseases of the kidney. The recipient of the fund is chosen annually. The committee will select the worker for 1914 about the first of February, and request all persons who desire to work under this fund, to send to the committee of the Edward N. Gibbs Memorial Prize Fund, 17 West 43d Street, N. Y. City, their application together with a statement of their fitness to prosecute such investigations, giving the laboratory in which they have studied, and any researches conducted by them, in order that the committee may be guided in the selection of the recipient of the fund for 1914.

The Colony of the Straits Settlements has voted a sum of £350 to Mr. Chamberlain's fund for the extension of the London School of Tropical Medicine.

News has been received from the Stefansson expedition that the scientific men and members of the crews of the *Alaska* and *Mary Sachs* were safe and well in winter quarters at Collinson Point, fifty miles from Flaxman Island, on the Arctic Circle.

The Puget Sound Marine Station located at Friday Harbor, Washington, will be open next summer under the directorship of Professor Theodore C. Frye, the head of the department of botany at the University of Washington. Plans are under consideration to increase facilities and to make most satisfactory the conditions surrounding the investigations in marine biology which are in progress. The laboratory will be open during the entire summer season. Professor Frye is now in the east consulting with those interested in the problems under consideration at Friday Harbor.

The Second Annual Conference of Editors of Agricultural Colleges and Experiment Stations will be held at the State University of Kentucky, June 25 and 26, 1914. Invitations to this conference have been sent to all the agricultural colleges and stations in the United States. Inquiries in regard to the meeting may be forwarded to B. E. Powell, executive secretary of Conferences, Urbana, Illinois.

At a meeting of the Royal Institute of British Architects, Mr. Lionel Earle, permanent secretary of the Office of Works, in the course of discussion on a paper by Mr. W. A. Forsyth on the repair of ancient buildings, mentioned that the treatment of decaying stone due to sulphuric acid in the air had

given his department much anxiety. The matter was of such far-reaching importance that the treasury had granted a sum of money for one, two, or three years to institute a scientific inquiry, and he hoped to obtain the services of Professor Laurie, of the Heriot-Watt College, Edinburgh, to that end. The Foreign Office had also consented to inquire of the governments of France, Germany, Italy, Greece and America whether any treatment had been evolved in these countries to combat this evil.

AN efficiency limitation of quite a different type from that imposed by the inadequate and dangerous quarters occupied by the United States Geological Survey is presented, according to the annual report of the director, recently made to Secretary Lane, in the restrictions placed in one way or another upon the selection of personnel. Under "lump-sum" appropriations there is a fair opportunity to obtain high-grade service in the scientific and technical positions, yet even here the restraining influence of precedent prevents attaching to the higher positions salaries that are more than a fraction of those which the well-trained specialists best fitted for those positions can obtain for similar work in the service of corporations. This condition has resulted in many of the members of the Geological Survey leaving government service at the time when they have become most valuable as public servants. Thus in the four and one half years ending January, 1913, the number of geologists who left the government service for the primary purpose of bettering their financial condition was 41, and these men are known to have received salaries outside of the public service amounting to an average immediate advance of 149 per cent., or practically two and one half times the salaries paid them by the Geological Survey.

THE Euphrates barrage from Hindich north to Bagdad was opened on December 12. It is the portion of the great irrigation works designed by Sir William Willcocks, the designer of the Assouan dam. The system, according to a dispatch from London to the Boston *Transcript*, will cost, when completed, no less than $115,000,000, of which $25,000,000 has already been expended on the present section of the work, known as the Feluja project. Three million acres of what were in early history the finest agricultural lands are to be eventually reclaimed. When the system is completed the Tigris, the Euphrates and the Akkar Kuf Lake will form part of a controlled system of canals, weirs and barrages, whereby the pernicious silt is to be separated, floods are to be prevented, and wheat-bearing land is to be nourished with water. It is estimated that the cultivated area will be doubled, and that the crop of wheat along the Euphrates will be trebled. The scheme would also result in a vast increase in the yield of cotton. It consists of providing a means of escape for the flood waters of the Euphrates along the depressions of the Pison, but it also entails the construction of a great central canal, regulators to control the supply from the Euphrates at the head of the Sakhnlawia, a weir on the Tigris, a canal for irrigation to the north of Bagdad, another canal along the right bank of the Tigris, and the building of a railway along the left bank of this canal for the transport of the harvests. Moreover, the construction work would include a railway to connect Bagdad with the Mediterranean by a short and cheap route. The project was submitted by Sir William to the Turkish government in 1909, after a year's study of the situation, a study which he continued through the two years subsequently up to the time of his resignation in July, 1911, as adviser to the Turkish Ministry of Public Works.

UNIVERSITY AND EDUCATIONAL NEWS

WESTERN RESERVE UNIVERSITY will receive from the McBride family of Cleveland a lecture foundation with an endowment of $50,000.

THE following changes concerning the admission of students to the Johns Hopkins Medical School have been announced. In 1913 the number of students in each class was limited to ninety. In order to receive consideration applications of incoming students must

this year be made by July 1. After that date the various applications will be sifted and an attempt made to choose the most likely ninety applicants. It has also been decided to increase the requirements for admission in chemistry and, in addition to the 150 hours of laboratory work in inorganic chemistry now required, an additional 90 to 100 hours of laboratory work in organic chemistry will be required of all students desiring to enter the school after October, 1914.

Beginning next year the two-year courses in the college of agriculture at the Ohio State University will be lengthened to three years. The Tuesday before October 15 is the date set for opening and the Friday before March 15, that for closing. Farmers' sons may, with this change made, come to school after harvest and complete the year's work before the spring work begins on the farm. No attempt to extend the subject matter is intended, and the length of the course is practically the same, but boys from the country may engage in practical farming while taking the agricultural course under the new system.

Plans are being perfected for the centennial of the first conferring of degrees by the Yale medical school. Special exercises will be held in Woolsey Hall on Monday afternoon of commencement week from 4 to 6, and historical addresses, the conferring of honorary degrees, exhibits and other features will be arranged.

Mr. A. W. McCoy (A.B., A.M., Missouri) instructor in geology at the University of Missouri, has been elected instructor in geology at the University of Oklahoma.

The General Board of Studies of Cambridge University have appointed Dr. Assheton to be university lecturer in Animal Embryology.

DISCUSSION AND CORRESPONDENCE

REPLY TO A RECENT CRITIQUE OF AN OLD REVIEW IN SCIENCE

In the current number of the *Bulletin of the American Mathematical Society*, December, 1913, pages 147–151, Professor E. B. Skinner makes erroneous statements regarding my review in Science[1] of Professor L. W. Reid's "The Elements of the Theory of Algebraic Numbers," and also regarding the history of the subject.

1. In my review I had said:

> After stating formally theorem *A* and devoting fifteen lines to its proof, the author informs us that the "theorem therefore fails." Similarly, on pages 250–251, theorems are formally stated and later shown not to hold in general. This peculiar style of pedagogy is decidedly a novelty to the reviewer.

Quoting only the first sentence and that incorrectly, Professor Skinner insists that the quotation puts the author in a wholly erroneous light. But the entire passage certainly makes clear that I was merely questioning the wisdom of this peculiar style of pedagogy. There was no need whatsoever for any comment in Science on the bare fact that the author stated a formal theorem in italics, devoted a half page to a "proof," and then indicated that the proof failed and that the "theorem" itself was false, repeating the same process on pages 250–251. I think I was justified in presupposing upon the part of a reader of my review that small degree of acumen which would enable him to conclude unguided that if an author devoted considerable space to a false theorem, the failure of the theorem was regarded by him as of sufficient interest to warrant attention. It is unfortunate that the author and Professor Skinner speak also of general theorems which they nowhere state explicitly and which if stated would be false, except in the very simplest cases, as they well knew.

2. In my list of important topics omitted from the book, I included erroneously that of class number. It occurs first on page 434, just seventeen pages before the end of the book. One may be pardoned for not looking at the end of a long book for a topic which should play a fundamental rôle in the whole theory.

3. The last paragraph of my review has gone through a remarkable metamorphosis in the hands of Professor Skinner. What I actually said was:

[1] Science, N. S., Vol. XXXIII., pp. 188–89, February 3, 1911.

In the matter of references the author has been particularly unfortunate. In a book barely entering upon the threshold of the theory, a scarcity of references would have been entirely justifiable. But to give hundreds of references to a certain report on the subject (excellent although it be) and to completely ignore the literature and not even mention the names of the discoverers of the theorems is against all scientific traditions.

What Professor Skinner says I said is:

Again, the reviewer, deploring the omission of references, says: But to give [as above].

My second sentence above (not quoted by Professor Skinner) shows that I did not deplore the omission of references. This sentence together with the one actually quoted by him show that what I deplored was misplaced references. As should be well known, Kummer created a highly complex theory of ideal numbers for the case of fields built upon roots of unity; then Dedekind created a simpler theory of ideals in complete generality and developed the subject at great length; then Hurwitz made a simplification which yields a brief and attractive exposition of the theory; also Dirichlet, Kronecker, Hilbert, Minkowski, Hensel and others have contributed to the development of the subject in various directions. A very large proportion of the theorems stated on pages 218–451, the part dealing with quadratic fields other than Gauss's important case, should have been attributed to Dedekind, provided a reference was to be given. But in these 234 pages, I find only four references to Dedekind, once to an alternative proof, once to a symbol, once to a simple lemma, and finally to a wholly subsidiary theorem. There are two references to Minkowski and one to each Woronoj (on cubic number fields), Hurwitz, Sommer, H. J. S. Smith and to Chystal's algebra. The references to the main theorems are to that excellent report by Hilbert, recently translated into French. As against the four wholly minor references to the originator of the general theory, Dedekind, there are 45 references to Hilbert's report (Professor Skinner's count of 38 for the entire book is misleading as he neglected references given in the body of the text). With a single exception, these 5 references are to passages in Hilbert's report in which Hilbert expressly attributed the results to other writers; had the author reached the higher parts of the theory, he would have needed many references to Hilbert's own important contributions. On my own part the impression that there were hundreds of such references was wrong; but that exaggeration is really beside the mark. The references are largely misplaced and that is evidently all I was emphasizing in the passage quoted above. I do not begin preparation for writing a book review by counting references, and I do not care a straw whether or not Professor Skinner's count of 158 as the total number of footnote references is correct; in any event only about 44 of these relate to the part under discussion. In the above extract from my review I expressly limited myself to the subject of the report and hence to algebraic numbers; consequently it is not a fair comment on that extract to speak of the large number and nature of the references in the introductory part on rational numbers. In all probability these references would have been like those discussed above had the report treated also rational numbers.

4. Professor Skinner states that my review was freely interspersed with exclamation points. As a matter of actual fact only two exclamation points appear in my two-column review. One is in

The author desires to bring out a closer relation between rational numbers and quadratic numbers. This he accomplishes by complicating the elements of rational numbers with the unnecessary machinery of quadratic numbers! We find on page 91 Wilson's theorem stated in the form

$$r_1 r_2 \cdots r_k + 1 \equiv 0 \pmod{p},\ k = \phi(p),$$

where $r_1, \cdots, r_k$ form a complete set of residues modulo p, a prime.

According to the Index, this is the first statement in the text of Wilson's theorem, which has been known since 1770 under the familiar form that $1 \cdot 2 \cdot 3 \cdots (p-1)+1$ is divisible by the prime p. After the complicated theorem is stated, proved, generalized and illustrated by several examples, the usual form is finally given. The second exclamation point was used in discussing a three-

page proof which could have been given in a few lines.

5. If, in the three years intervening between my review and his attack on it, Professor Skinner had given less time to the counting of footnotes and more time to the comprehension of the passages quoted from my review and to the unquoted context of those passages, he would possibly have saved himself from "careless and inaccurate statements," instead of attributing that term so freely to my review.

6. Professor Skinner makes on page 150 the remarkable statement:

> Furthermore, the author has put in a very clear light the historical sequence of the ideas which led to the development of the theory.

On the contrary, the author made no such pedagogical blunder. He wisely did not attempt to give any idea of Kummer's ideal numbers, the operations on which are so delicate that one must use the utmost circumspection (as remarked by Dedekind in his important historical papers in Darboux's *Bulletin*). Nor did the author present the second stage (Dedekind's viewpoints) in the historical development of the theory. For most obvious reasons the author refrained from presenting "the historical sequence of the ideas," and confined himself to the simplified present-day exposition of the theory, as far as he went.

L. E. Dickson

A REJOINDER TO DR. DAVENPORT

The task of the critic is always a disagreeable one, and it is only the conviction that the fate of eugenics as a science depends on the repudiation of much of the recent work of the Eugenics Record Office which impels me to reply to Dr. Davenport's letter in Science of November 28. I shall confine myself to the three points he raises regarding the paper on heredity in epilepsy although these points are not in the least representative of my criticism of that paper. Indeed, I dealt with not one, but a whole series of publications in which Dr. Davenport is concerned.

(*a*) Dr. Davenport states that

> First, Dr. Heron seems to assume that whenever a symbol in a pedigree chart is not accompanied on the chart by some special description it stands for a person about whom nothing is known. He calls attention to numerous cases where, notwithstanding, the corresponding individual is described in the text. The assumption is a gross error. The chart shows mainly the interrelationship of individuals, and indicates only certain traits.

Bulletin No. 2 of the Eugenics Record Office[1] is entitled "The Study of Human Heredity" and the opening sentence reads:

> The following methods are in use at the Eugenics Record Office. . . .

The "plan of charting" adopted is described in section 2 and it is there stated that while the letters E, F, I, N, etc., placed in or around the square or circle which stand for male or female, indicate that the individual in question is epileptic, feebleminded, insane or normal, etc., "when no letter accompanies the individual symbol it means that no definite data had been secured at the time the chart was made" (page 4). Further, Plate V. on page 16 is entitled "Key to Heredity Chart" and there examples of the symbols used are given. The first two are the square and circle without any accompanying letters and the description given is "No data." Again, in his tables Dr. Davenport uses a symbol X which he defines as "Unknown" (I pointed out that more than half the individuals entered in the tables were described by Dr. Davenport himself as "unknown"). Now in the great majority of cases the square or circle without any accompanying letter corresponds to an individual marked "unknown" in the tables, but I pointed out several cases where mistakes had been made. To take the first example I gave in my paper, Fig. 10, case 469, the chart shows two sisters one of whom is marked epileptic while the symbol for the other is left blank to indicate that "no definite data had been secured at the time the chart was made" or that there were "no

[1] It was reprinted in Bulletin No. 7 of the Eugenics Record Office, September, 1912.

data." In the description of the pedigree the first sister is stated to be "certainly epileptic," the second merely "shows signs of epilepsy," while in Table I. both are definitely entered as epileptic. Yet these different statements occur in one and the same study of inheritance in epilepsy.

(*b*) Dr. Davenport writes that,

> Second, Dr. Heron catalogues with infinite pains, "errors" in citing the case numbers. Here he has fallen into a trap which the authors unconsciously prepared for him. To avoid the possibility that a person who is not authorized should connect an individual at the institution with his family history it was decided to apply alterations to the case numbers which enable the authors, but not the ordinary reader, to identify the case.

My criticism was summed up as follows:

> Tables A, C and D (of Drs. Davenport and Week's paper) thus contain particulars regarding the relatives of 74 normal parents. In only 30 cases do the entries agree with the tables from which they are supposed to have been extracted, or with the pedigrees given in the paper. In 13 cases out of 74 the case numbers do not agree, while 9 cases which ought to have appeared in Tables C and D have been omitted.

The whole of the errors made were definitely cited by me and the following may be given as examples. Case No. 4529 of Table IV. appears as No. 4521 in Table A *of the same paper* and No. 2124 as No. 2129. Comparing Tables VI. and C we find that No. 335 appears as No. 332, 481 as 483, $\left.\begin{matrix}504\\3781\end{matrix}\right\}$ b as $\left.\begin{matrix}503\\3781\end{matrix}\right\}$ b, 1705 as 1704, etc. Yet Dr. Davenport now states that these changes were deliberately made by him to hide the identity of the individuals dealt with. I am quite unable to understand how any individual can be identified as No. 4529 and yet escape identification as No. 4521. Perhaps Dr. Davenport will also explain how a pedigree came to appear in Bulletin No. 4, Table VII. as No. 2983, only to be changed in Table D of the same paper to No. 2984, to reappear at the Eugenics Congress as No. 2983 in Table VII. and to return to No. 2984 in Table C.

(*c*) Dr. Davenport states that I overlooked the fact that the details of his pedigrees were sometimes entered in 5 columns and sometimes in 9, 10 or 11 columns (not only in 10 as he states). I was well aware of the fact and made no objection to this procedure since in most cases Dr. Davenport has made up the deficiencies of his "5-column" classification by a long series of footnotes. I did object, however—to cite only a single example—when I found in case 2487 that there were four different versions of the mental condition of a single fraternity of 12 children and pointed out that Dr. Davenport gave of those who died early 0 or 2, of the "unknown" 0, 1 or 6, of the insane 0 or 1, of the neurotic 0, 3, 4 or 5, and of the alcoholic 1 or 2, according to the page consulted. It is for Dr. Davenport to justify these differences.

Finally I would ask those who wish to judge between Dr. Davenport and myself to read my memoir in conjunction with those of Dr. Davenport which I have criticized. They will then be able to judge for themselves whether or not my criticisms are justified. They involved far more serious matters than those to which Dr. Davenport now endeavors to reply.

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SCIENTIFIC BOOKS

Researches in Physical Optics with Especial Reference to the Radiation of Electrons. Part I. By R. W. WOOD. Columbia University Press (New York, 1913). Pp. 133, plates 10.

This volume, whose subtitle serves to illustrate the manner in which the electron is dominating current thought in physics, is the most recent number of the Ernest Kempton Adams Series. Of the eleven papers which are here collected all are experimental in character: a large number of the results have already been announced in other places, mainly in the last three or four volumes of the *Philosophical Magazine*.

In point of importance, the first two of these essays, dealing with the truly remarkable phe-

nomena found in the resonance spectra of iodine vapor—phenomena discovered by the author—ought probably to rank highest. The fundamental fact in regard to resonance spectra, namely, that a vapor when illuminated by monochromatic light which comes from a single direction will become self-luminous and will reemit light of the same wave-length in all directions, would appear to put this phenomenon into a category entirely different from that of ordinary fluorescence and to make it extremely worthy of investigation.

The first paper deals with the advantages which came from the use of iodine vapor in place of sodium vapor, and with the structure of the absorption spectrum of iodine, which with Wood's forty-foot spectrograph shows no less than seven lines within the space occupied by the green mercury line alone. Here also is described the curious and unexplained effect of mixing helium with the iodine vapor, namely, the transformation of resonance spectra into banded spectra. Another unexplained phenomenon in this connection is the fact that when the exciting beam of light is polarized this polarization is passed on to the lines of the resonance spectra.

The second paper describes the 40-foot spectrograph with its now celebrated "pussy-cat" attachment and also deals with the absorption spectra of iodine and the emission spectrum of mercury. Wood estimates the number of absorption lines in iodine vapor at 50,000, and recommends it as superior to sunlight for testing large gratings. Important extensions of this work on iodine vapor are reported in the current (November) number of the *Philosophical Magazine*.

The third paper deals with the resonance spectrum of another vapor—that of mercury—which is excited only by ultra-violet light of wave-length 2536. Here is related the discovery of "secondary" resonance, a remarkable radiation, which comes, not from the vapor directly illuminated by the exciting ray, but from those portions of the vapor which are illuminated only by primary resonance radiation. A most interesting feature of this paper is the experimental passage from diffuse to regular reflection of resonating vapor, *i. e.*, from volume to surface reflection. Experiments show that the resonance radiation "begins to weaken at a pressure of about 2 cm. (mercury vapor) and is practically gone at 70 cm."

Next follows a not very successful attempt to determine the anomalous dispersion of mercury vapor in the neighborhood of λ 2536, by use of Puccianti's method. Among the most interesting results in these papers must be reckoned those in which Professor Wood has determined, by experiment, the connection between transparency of a layer of metallic globules and the diameter of those spheres. Using a layer of mercury droplets deposited as "dew" on a quartz plate and examining them for transparency by use of infra-red rays of wave-length 112 μ he finds that these metallic particles have no effect in stopping long heat waves until their diameter begins to exceed one tenth of a wave-length. Very striking also is the fact that such a sheet of small metallic particles—packed together in such a way that they almost touch—seems not at all to interfere with the transparency of those portions of the plate not covered by the metal; the plate remains as transparent for waves of 112 μ as for waves of 1 μ.

Paper No. 6, dealing with diffraction gratings having a controlled groove-form, does not quite reach the level of those which precede it. The next contribution contains some excellent photographic examples of the reflective power of nickel films on glass and numerous details concerning the author's method of depositing these films.

Paper No. 8 carries the title of "Selective Absorption of Light on the Moon's Surface and Lunar Petrography," the latter half of which impresses one as rather ambitious. "Petrography" is a word which has too definite a meaning to be employed as a description of local differences of color either on the moon or on any other body. The method employed is that of using different ray-filters for photographing the moon with light from three regions in the spectrum; and then combining the three negatives into a three-color

picture. The silvering process was evidently described during a moment of relaxation when the author's characteristic humor came to the surface as follows: "Personally I never weigh my nitrate of silver, as I enjoy the element of the personal equation which enters the problem when scales are dispensed with." How seriously this is to be taken may be judged from one or two of his immediately following sentences. "From one to two grams to 100 c.c. of distilled water is about right." "Unfortunately things as described above seldom happen at the first trial." "It troubled me much when my personal equation contained one more variable than at present, but I have not seen it occur recently. As the production of the uniform blue film depends upon getting the proportions just right, I suppose the beginner had better mix measured amounts for each trial unless he has access to a large jar of silver nitrate which 'belongs to the department.'" "The cause of this I do not know. Probably it is osmotic or perhaps catalytic!"

The results contained in the next paper, entitled, "Note on the electron atmospheres of metals," are capable of a quite different and less significant interpretation than that given by the author, as has already been pointed out by several other investigators.

The resolution of the four principal mercury lines, by a five-inch plane grating, ruled by Anderson at Baltimore, is discussed in Paper No. 10, and speaks well for the high quality of the grating.

The eleventh paper concludes the series with an interesting explanation and experimental verification of the "Imprisonment of Radiations by Total Reflection."

Of the volume as a whole, one hardly knows whether to admire more the boldness of ideas which prompt the experiments or the manipulative skill with which they are executed.

HENRY CREW

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Astronomy: A Popular Handbook. By HAROLD JACOBY, Rutherford Professor of Astronomy in Columbia University. The Macmillan Company, New York. 1913.

Most astronomers yield at one time or another to the desire to write some popular treatise on astronomy. Professor Jacoby has prepared his volume in the effort "to meet the wishes of the ordinary reader who may desire to inform himself as to the present state of astronomical science, etc." The book is intended also to serve for use in high schools and colleges. To meet this double end, the author has placed all the mathematical notes and explanations in the appendix, where they are at the service of students, while the main body of the text is free from mathematics, which might discourage the "ordinary reader." This method of arrangement is not unusual, but the author has carried it out more systematically than is usually done.

Professor Jacoby's treatment of the subject is distinctly out of the ordinary, and it is this originality of method and style which may well furnish the *raison d' être* for this addition to our astronomical literature. The first chapter is in the form of a general survey of the universe, a prelude to the detailed descriptions which follow. In the third chapter methods are given for finding the planets and stars. This chapter, however interesting for other reasons or valuable for intellectual training, does not impress one as containing the simplest methods for gaining familiarity with the stars and planets. Monthly maps are now published giving the appearance and positions of planets and comets as well as the stars, and it is doubtful if any verbal description, tables and small diagrams can compare in efficiency with such maps in assisting an ordinary reader to the identification of celestial objects. The author, however, would doubtless encourage the use of such maps in connection with the reading of the book. Chapter V. gives a brief but admirable discussion of the sun dial with a description of the manner in which one may be constructed by the reader. The earth and its relationships are handled in an original and interesting way. Under "Moonshine" the author presents the leading facts about our satellite, giving the usual proof of the absence of an atmosphere and the probable cause of its disappearance. No reference is made to the

conclusions of Professor W. H. Pickering, and others, regarding a slight atmosphere and various changes of the lunar surface. The author evidently has little confidence in these observations, since they, if trustworthy, would be of exceptional interest to the "ordinary reader." The different members of the solar system are taken up in order and briefly but clearly described. Probably no other astronomical subject is of such popular interest as the question of the presence of intelligent life on Mars. The author states: "We conclude that neither by visual nor by photographic evidence has the existence of an artificial network of markings been proven, or even rendered highly probable. Therefore the time has not yet come when we shall have to inquire whether geometric lines indicate the presence of intelligent inhabitants: that time will arrive if the lines themselves are ever shown to possess a real or even a highly probable existence." This view is doubtless shared by the great majority of astronomers at the present time.

Throughout the book Professor Jacoby calls attention to the familiar celestial phenomena of life, such as the rising of the sun and moon and their summer and winter paths. In calling attention to such facts and explaining them in a popular manner he has done a real service to the readers of his book. Even among educated people few can answer promptly the question, "Where does the moon rise?", and its changing path during the month and year is either not noticed or regarded as a mystery.

The volume is attractive in form, appears to be free from errors, and is admirably, if not profusely, illustrated. Many lines of recent astronomical advance have been lightly referred to, if at all, but this is inevitable in a popular treatise of such wide scope. The paramount importance of photography in research at the present time might well have been emphasized somewhat more strongly. On the whole, the book is exceptionally well written, and as a popular exposition of the whole field of astronomy is unexcelled.

S. I. Bailey

Elliot's Review of the Primates

For many years the Primates have been in need of systematic revision. The last general work on the order, Forbes's "Handbook," was published in 1894. Study of the group since then, particularly in Berlin, London and Washington, has resulted in a great increase in the number of recognized forms and in the modification of previously accepted views regarding many of those earlier known. In no one of the chief centers of activity is the material extensive enough to form the basis of a general review of the order, and in no two has a common standard of work existed. The resulting confusion was such that the understanding of relationships and the identifying of specimens had become in the larger genera impossible. To remedy these conditions and to establish a foundation for new work are the main objects of Dr. D. G. Elliot's "Review of the Primates."[1] This book is one of the most elaborate monographs ever devoted to a single order of mammals. By its publishing the outlook on the primates has been altered in a way that can be appreciated by those only who have for some time been actively occupied in the study of monkeys. In its 1,351 quarto pages may be found a complete review of the work done in the past by the author himself, his contemporaries and predecessors. It contains descriptions of all the known species drawn up by one person from direct examination of the specimens in all the principal museums of the world. Finally the series of photographs reproduced in 111 of the plates is so well selected and so fine in quality that it might be said almost to exceed in general usefulness the specimens hitherto existing in any one museum.

The inception and plan of the work are thus described by the author (Preface, pp. iii–ix):

[1] "A Review of the Primates," by Daniel Giraud Elliot, D.Sc., F.R.S.E., etc. Monographs of the American Museum of Natural History, Vols. 1–3. Three volumes, quarto, with 169 plates (28 colored). New York, published by the American Museum of Natural History (1912), June, 1913. Price, $30.

"This Review of the Primates is the result of a casual suggestion of my friend Frank M. Chapman, Esq., that I should 'write a book on monkeys.' The magnitude of the task—to compel all the described forms of the Primates to present themselves in their representatives for critical examination and comparison—was thoroughly appreciated, and also it was equally well understood that no institution in the world contained a collection of these animals sufficiently large to permit a work like the present to be completed by its aid alone. . . . Twice were the museums of England and the Continent visited, . . . and during a journey around the world, the museums and gardens of the Far East were also visited and their collections carefully studied. The author has seen and taken a description of nearly all the types of the primates extant in the world today, and there is not a collection of these animals of any importance existing at the present time with which he is not familiar. The results of five years' continuous study are therefore embodied in this work. . . . In the recognition of apparently distinct forms, subspecies in only comparatively few cases have been accepted, because intermediates between what are recorded as species have rarely been found in this order, and neither of two forms, no matter how closely they are evidently related can properly be deemed a subspecies, no intermediates having been observed. Also the author has not seen his way to establish a subspecies between the dweller of an island and one of the mainland, because, no communication being possible, the appearance of intermediates would seem most improbable. . . . In the present work there are altogether fifty-five complete monographs. . . . Each member of the order has been treated after the following method. First a general review is held of the genus accepted, the type fixed and description given; then remarks are made on the appearance and general habits of the species the genus contains, followed by a review of the literature and the geographical distribution, and a key by means of which it is possible that all the species of that particular genus may be recognized. Then each species is taken up in regular sequence, its synonymy given and the type locality and geographical distribution recorded; the present location of the type, if existing, is then told, after which the peculiar characters of the species, if it possesses any, are given, followed by such remarks as may be necessary upon the relationship the species under review may have with some other in the genus; then a full description and measurements of the type if possible, concluding with an account of the habits so far as they may be unquestionably known. . . . The author can not refrain from calling attention to the illustrations produced by the methods and greatly improved instruments invented by the special photographer of the American Museum, Mr. Abram E. Anderson, which for clearness and perfection of detail, have possibly not been heretofore equalled. Mr. Anderson was sent to London expressly to photograph the crania in the British Museum. . . . The colored illustrations have been selected from those published in the *Proceedings* of the Zoological Society of London. . . . Those of the different species from life were taken by Mr. Lewis Medland, F.Z.S., of London, and certain excellent figures taken by Mr. E. L. Sanborn from animals living in the menagerie of the New York Zoological Society. . . . All the species and races known to the author that have been described prior to June 1, 1912, are included in the three volumes. After the date mentioned, the advanced state of the press work did not permit of any additions, except in an appendix to the third volume."

Following the preface is an introduction of 94 pages, a bibliography of 6 pages, a table of contents, lists of illustrations, list of genera and species in volume 1, and an "errata" calling attention to the single mistake which the author thought necessary to correct. The introduction deals with the general subjects of classification, variation and geographic distribution. There is also a list of the generic names that have been proposed for members of the order, and a complete synopsis of the arrangement adopted: 2 suborders, 8 families,[2]

[2] Although the family *Hylobatidæ* is very properly used to distinguish the gibbons from the true

55 genera,[3] and 588 species and subspecies. Except for the general accounts in the introduction there are no definitions of families and higher groups. There are no keys to the genera, while those provided for the species are not dichotomous.[4] The account of each species is arranged under the following heads: synonymy, type locality, geographic distribution, general characters, color, and measurements, to which is usually added a discussion of characters and some account of habits. Cranial and dental peculiarities are either ignored or superficially treated; a lack which is partly compensated for by the abundance and excellence of the illustrations.

The nomenclature of the Review is uncompromisingly founded on the law of priority.[5] The author's cheerful acceptance of the results, however inconvenient they may temporarily appear, should do much to counteract the present tendency to seek relief in exceptions to the uniform application of this rule. Discussing the name *Simia,* recently shown to apply to the Barbary ape instead of to the orang or chimpanzee, Doctor Elliot says:

"This procedure may be regretted by mammalogists generally, for *Simia* has always been connected with some group of the great apes, but the reasons advanced for doing this were faulty, and an error was committed, and no matter how familiar this act may have become to authors and others generally, yet it was still an error, and therefore something necessary to change and correct. No error can ever become truth simply by toleration and should never be continued when discovered for any reason, and particularly not for the totally insufficient one that the change would inconvenience the memories of certain writers."

The same uncompromising attitude is assumed with regard to every question discussed in the Review: "The conclusions given, no matter how they may disagree at times with the opinions expressed by other laborers in the same field, have in every case been reached only after careful and patient investigation." This strongly personal character of the work is manifest on every page. While it gives the text its chief value it, in connection with the peculiar circumstances under which the manuscript was prepared, accounts also for the main defects. These are the lack of proper correlation between notes made at widely different times and places,[6] and the generally

anthropoids, the number of such groups recognized is still too small. This is particularly true of the American monkeys, all of which, in spite of their great diversity of structure, are, as usual, crowded into two families.

[3] The following generic and subgeneric names are here published for the first time: *Rhinostigma* (I., xl.), type *Cercopithecus hamlyni* Pocock; *Allochrocebus* (I., xl.) type *Cercopithecus l'hoesti* Sclater; *Neocebus* (I., xl.), type *Simia cephus* Linnæus; *Insignicebus* (I., xl.), type *Cercopithecus albigularis* Sykes; *Neopithecus* (I., lx.), accidental renaming of *Neocebus; Altilemur* (I., 111), type *Cheirogaleus medius* Geoffroy; *Brachyteleus* (II., 49), substitute for *Brachyteles* Spix; *Neocebus* (II., 224), included species: *Pithecus resimus, P. validus, P. alacer, P. karimoni* and *P. fuscus* (not *Neocebus* Elliot, I., xl.); *Melanocebus* (II., 296), included species: *Lasiopyga leucampyx, L. pluto, L. nigrigenis, L. boutourlini, L. opisthosticta, L. aurora, L. stuhlmanni, L. neumanni, L. doggetti, L. princeps, L. carruthersi, L. nictitans, L. n. laglaizi, L. sticticeps* and *L. martini; Pseudogorilla* (III., 224), type a young male *Gorilla gorilla* supposed to represent the *G. mayema* of Alix and Bouvier.

[4] There are 17 alternatives beginning with the words "General color" in the key to the species of *Pygathrix* (III., 30–32) and 24 beginning with the word "Hands" in that to the species of *Pithecus* (II., 189–190). Such tabulations of characters can not strictly be regarded as keys.

[5] Except as regards the formation of names. Here the International code is abandoned and personal taste is freely indulged, not always with happy results from the point of view of the purist. For instance, the generic name *Ateles,* evidently intended by Geoffroy as a transliteration of the Greek adjective ἀτελής, is changed to *Ateleus* (II., 21) with the following comment: "Ατελησ (sic α priv. and τελοσ (sic), εοσ (sic) a neuter noun, which with the α priv. would be, when Latinized, *Ateleus.*"

[6] At least it is difficult otherwise to explain the frequently-recurring discrepancies such as: the statement on one page that an animal is clove brown and on the next that it is jet black (III., 109, 110); "upperparts bistre" and "upperparts

superfical quality of the descriptions and technical discussions. Nowhere does the author give evidence of felicity in the treatment of those characters of fundamental importance derived from skulls and teeth.[7] The vital part of a monograph of the order therefore remains unwritten. To an experienced systematist the results of such tendencies can not fail to bring annoyance and disappointment, while to a beginner, or to a person who has no access to large collections of primates, they must render the book often confusing and misleading. The frequent inaccuracy of statement by which the text is marred[8] will be a further source of difficulty to every one who attempts to use the Review in any serious work.

In these initial numbers of its series of "Monographs" the American Museum of Natural History has established a high standard of excellence in book-making. Good paper, clear type and unsurpassed half-tone plates are its main characteristics. Consistent italicization of generic and specific names would have made the text more easy to use, one series of numbers instead of four would have made the plates less perplexing to cite, while "editing" might have been expected to eliminate an allusion to the opossum as a member of the order Carnivora (I., xxi.), together with such solecisms as "cratarrhine and platarrhine" (I., xxi.), and the almost uniform incorrectness in the printing of Greek.

GERRIT S. MILLER

[7] The striking peculiarities of the skulls and tooth cusps in the lemurs are barely mentioned; the equally interesting molars of the American monkeys receive no more attention (the remarkably primitive structure shown by those of *Alouatta* is not even alluded to); the molars of the three genera, *Pongo, Gorilla* and *Pan,* the cusps of which furnish unmistakable generic characters, are described in practically identical terms; the skull of an ordinary immature male gorilla (the age clearly indicated by the open sutures shown in the photographs) is made the type of a new genus "*Pseudogorilla*" (III., 224), supposed to be intermediate between *Gorilla* and *Pan.* Cranial characters are described for none of the 8 subgenera and for only 3 of the 84 species and subspecies of the genus *Lasiopyga,* though in the preliminary discussion of the monkeys of this group the remark is made that: "Cranial characters . . . are of supreme importance in the discrimination of species . . ." and also that they furnish "one of the most important methods of determining species" (II., 290).

[8] The following examples have been found during actual use of the book, and without search for errors as such: *Tarsius philippinensis* for *T. philippensis* (I., 9, 10, 12, 13); *Nycticebus menagensis* Lydekker, *Zool, Rec.,* etc., for *Lemur menagensis* Lydekker, etc. (I., 32); I. Geoffroy, Cat. Primates, p. 51," cited as authority for alteration of *Brachyteles* to *Brachyteleus* (II., 49) though the change is not mentioned by Geoffroy. (It is apparently published for the first time by Elliot); *Cynopithecus niger* Desm., Mamm., etc., for *Cynocephalus niger* Desm., Mamm., etc., (II., 162); *Cercopithecus mona* Hollister for *Lasiopyga mona* Hollister (II., 350); description of color of *Pygathrix melanolopha* beginning: "Long black hairs along the forehead, golden cream yellow" (III., 33); original reference to the name *Presbytes batuanus* given as "*Presbytis batuanus* (!) . . . p. 470" (III., 44) when it was actually published on p. 65 and with the masculine form of the generic name; *Pygathrix femoralis* (III., 45), Horsfield cited as authority, though first description was published by Martin, type locality said to be "Tenasserim, Bankasun, (Thomas)" though Thomas merely recorded a specimen from Bankasun as "precisely similar" to the type; *Pygathrix obscura* (III., 52), Reid cited as authority though he is said to have published no description; *Callithrix goeldi* Thomas . . . p. 100 for *Midas goeldii* . . . p. 189 (III., 261 and I., 224, *not* 324 as cited on III., 261). black or nearly so" in two paragraphs of a description based on a single specimen (II., 200); "no skull" as part of a color description (III., 70); the application of the same new subgeneric name to two different groups (II., 224, 319); the application of two new names to one group (I., xl., lx., and II., 319); the listing of the name *Pavianus* under Lemuroidea (I., xxviii.), and again under *Anthropoidea* (I., xxxii.).

NOTES ON METEOROLOGY AND CLIMATOLOGY

DYNAMIC PRESSURE UNITS

BEGINNING January 1, 1914, the Blue Hill Meteorological Observatory will use dynamic units of pressure instead of millimeters of

mercury for barometer readings (760 mm. = 29.92 in. = 1,013,303 dynes = 1,013.3 millibars). Also temperatures will be expressed in absolute centigrade degrees (273° A. = 32° F.). Until January 1, 1915, the old units will be retained for comparison with the new. Professor Alexander McAdie, director of the observatory will be glad to help any one wishing to adopt this new pressure scale. These changes were first proposed for adoption in the United States by him in 1908.

In the report for the year ending March 31, 1913, the Meteorological Committee of England announces that the centibar or millibar will be used instead of the inch as far as possible for all barometric measurements. Specimens of daily and weekly weather reports are given with pressures expressed in dynamic pressure units instead of inches of mercury, and with temperatures in absolute centigrade degrees.

RADIATION AND CLOUD GROWTH

In the October *Meteorologische Zeitschrift*[2] Dr. C. Braak, of Batavia, Java, ascribes to radiation certain peculiar phases in the development of cumulus clouds. His description of the formation of these clouds on a calm day may be stated as follows. When the rising sun has warmed the earth sufficiently to drive local air masses to the condensation level, at first single, then many small cumuli appear which soon cover the whole sky. Here and there larger heads rise out of the rather flat cloud sheet. Soon after reaching their maximum height they disappear. If the cumulus growth continues to the cirrus level (about 10 kilometers altitude) the top flattens out. The lower column melts away and leaves this growing sheet. When through energetic upward movement the cumulus cloud rises to even greater heights, there is no longer a maximum level where the vertical movement stops; the condensed moisture falls out, and in the upper parts of the cloud the air flows toward all sides, forming gigantic cirrus rays.

Thus there seems to be a division of the atmosphere into two parts as regards cloud building. This has a certain analogy with the division of the atmosphere into troposphere and stratosphere: the former designates the atmosphere to a height where decrease of temperature with altitude ceases, and the latter, the isothermal region of unknown vertical extent above this. According to Messrs. Gold and Humphreys[3] this is a radiation effect of the air. Below the stratosphere radiation exceeds absorption and convection balances the loss of heat; while in the stratosphere absorption exceeds radiation so the temperature rises over that of convective equilibrium. If one considers the disappearance of the lower part of the cumulus cloud to be the result of cooling and the continuance and energy of the upper part as the result of warming, the analogy becomes nearly complete. Observations in cumulus clouds over Batavia within the lower few kilometers show that the clouds are colder than the surrounding air at the same level. Radiation may thus have greater importance in cloud processes than is commonly assigned to it.

EXCESSIVE PRECIPITATION

Some recent heavy rains have brought out the following records of excessive rainfall for short periods.

Period	Amount	Place	Date
24 hours	1,168 mm.[4]	Baguio, P. I.	July 14–15, 1911
24 hours	544 mm.	Alexandria, La.	June 15–16, 1886
18½ hours	523 mm.	Montell, Tex.	June 28–29, 1913
3 hours	406 mm.[4]	Concord, Pa.	August 5, 1843
80 minutes	292 mm.[4]	Campo, Cal.	August 12, 1891
30 minutes	235 mm.[4]	Guinea, Va.	August 24. 1906
20 minutes	205 mm.[4]	Curtea-de-Arges, Roumania	July 7, 1889
14 minutes	100 mm.	Galveston, Tex.	June 4, 1871
5 minutes	38 mm.	Fort McPherson, Neb.	May 27, 1868
30 seconds	4 mm.	Valdivia, Chile	June 11, 1912

[1] See Alexander McAdie, "New Units in Aerology," *Scientific American* Supplement, December 6, 1913, p. 357.

[2] "Uber den Einfluss der Strahlung auf die Wolkenbildung."

[3] See Dr. W. J. Humphreys, *Jour. Franklin Inst.*, March, 1913, pp. 216–222.

[4] Probably world's records.

SOME RECENT PUBLICATIONS

DR. NILS EKHOLM in a recent work[5] makes use of isallobaric charts (charts of equal changes of pressure) in addition to the usual isobaric charts. His study of the former indicates that pressure changes are of primary importance, while cyclonic and anticyclonic phenomena are secondary.

A thorough study of the thunderstorm observations in Germany for 1910 has recently appeared.[6] The thunderstorm observations of 1,570 stations are printed in extenso and summarized in a number of tables. The mean velocity for 979 thunderstorms was 38 kilometers per hour; the extreme velocities were 9 and 95 kilometers per hour. Twenty per cent. of the thunderstorms came in May, forty per cent. in June and twenty per cent. in July. There is a special article on the destructive thunderstorm of May 11, 1910.

The British Rainfall Association under the direction of Dr. H. R. Mill deserves credit for its large 52d volume "British Rainfall, 1912." Part 1 contains three special articles on "The Great Rainstorm of August 25–26, 1912"; "The Wettest Summer in England and Wales," and "The Seathwaite-pattern Raingauge." Part 2 is an extensive treatment of the British rainfall data of 1912. Part 3 is a general table of the rainfall observed at 5,272 stations.

The report of the Franco-Swedish sounding-balloon expedition in Lapland 1907, 1908 and 1909 has been published recently. As in middle latitudes, the base of the stratosphere was encountered at a mean elevation of twelve kilometers with temperatures of — 50° to — 60° C. These temperatures are higher than those at the base of the stratosphere in equatorial regions where records of — 80° C. are not uncommon.[7]

The pumping action (suction) of the wind particularly in mountain stations offers a serious obstacle to accurate barometer readings. Mr. G. v. Elsner in a monograph, "Über den Einfluss des Windes auf den Barometerstand an Höhenstationen,"[8] discusses this at length. As yet no way has been found to eliminate this wind effect.

NOTES

IN recognition of the fact that the Blue Hill Meteorological Observatory is now part of the Division of Geology of Harvard University, the members of that Division visited the Observatory November 8. Professor Alexander McAdie, the new Director, gave an address on "Modern Methods of Frost-fighting."

The Smithsonian Institution is to reopen the Langley Aerodynamical Laboratory, which was closed a few years ago. The first serious contribution from the scientific side of aeronautics is to be found in the work of Langley. His original purpose was not to construct a flying machine, but to determine the laws governing flight. Two wind tunnels are to be made for tests on models. In addition to these experiments, an aircraft field-laboratory is proposed for measurements of stress, moments of inertia, etc., and for the adjustment and repair of several full-scale land and water aeroplanes.

The part which high humidity plays in producing heat stroke was well illustrated in Vienna on August 20, 1913. With the relative humidity around eighty per cent. and temperatures between 20° and 23° C., several suffered from heat prostration.

The council of the Royal Meteorological Society has awarded the Symons Gold Medal to Mr. W. H. Dines, F.R.S., in recognition of the valuable work he has done in connection with meteorological science. The medal will be presented at the annual meeting of the society on January 21, 1914.

WE learn from *Nature* (London) that in November the British Meteorological Service

[5] "Das Wetter auf der Nordsee während der erste Hälfte von Juni 1911," Copenhague, 1913.

[6] Th. Arendt, "Ergebnisse der Gewitter-Beobachtungen im Jahre 1910," *Veröff. d. Kön. Preuss. Met. Inst.*, No. 266.

[7] See *Scientific American*, December 6, 1913, p. 432.

[8] *Veröff. d. Kön. Preuss. Met. Inst.*, No. 257.

began to issue comprehensive meteorological charts of the north Atlantic, somewhat similar to those discontinued by the United States Weather Bureau in August.

Dr. Julius Von Hann's first section of the third edition of his "Lehrbuch der Meteorologie" is now for sale by the publisher, C. H. Tauchnitz, of Leipzig, at 3.60 Marks.

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SPECIAL ARTICLES

MUTATION IN TOBACCO

Although recent work by Heribert Nilsson[1] and Davis[2] shows that the sudden changes which were observed in *Œnothera Lamarckiana* can be logically and simply explained by assuming a heterozygous parent, one should not conclude that this seriously weakens the general theory of the origin of new types by mutation. Even if the indirect evidence compiled by De Vries were also to be rejected, there remain a considerable number of mutations that have arisen in homozygous material of known ancestry. The truth of this statement is apparent if it is recalled that such a careful investigator as Morgan has witnessed the origin of over 150 such changes in *Drosophila*. Controlled botanical evidence is not as voluminous, though plant geneticists have all observed phenomena that seem best interpreted in this manner. For this reason we hope it is not out of place to describe the origin of a variation that appeared in 1912 in a field of Connecticut shade-grown tobacco, which seems likely to be of very great commercial value.

The variety of tobacco grown under cheesecloth cover in the Connecticut valley is called Cuban. It was first grown in this country in 1904 from seed which was brought from Cuba the previous year by Mr. William Hazelwood, of New York City. The crop of 1904 was very variable, but Hasslebring[3] has shown that this type of variability is due largely to the poor method of saving seed in Cuba. It is the result of a mixture of seed from various types of plants, for crossing seldom occurs naturally.

Individual plants were selected from the 1904 plot which was grown from Cuban seed, and self-fertilized seed produced by covering the seed head with a Manila paper bag. These individual selections were grown in row tests in 1905 and for succeeding years until 1909. The individual rows grown from self-fertilized plants presented a uniform appearance. Of the earlier types all proved of little commercial value except strain 13. One line known as 13–29 proved superior to all others in the value of the cured leaves. A considerable number of self-fertilized seed plants were saved from this line in 1908 and were used for commercial planting in 1910 at the Windsor Tobacco Growers' Corporation in Bloomfield, giving a crop of uniform appearance, in which no variations of importance were noted. A large quantity of seed was saved from this crop, although individual plants were not selfed, as it seemed very improbable that crossing would take place under the cheese-cloth cover, and even if some crossing took place, it was assumed that it would be between homozygous individuals. The Cuban variety was thus selfed for five generations, and in all probability for a sixth generation, and gave every evidence that it was of a homozygous nature.

In 1912 about one hundred acres, or over a million plants, were grown from the seed of the 1910 crop at the Windsor Tobacco Growers' Corporation. The general appearance of the crop this year was very uniform, but when clearing the field in the fall, one of the workmen was very much surprised to discover that one of the plants he had just cut down was very much taller than the others, and bore a large number of unpicked leaves. This plant was brought to the attention of the plantation manager, Mr. J. B. Stewart, who recognized the possibilities of such a plant. After systematic search two more such plants were discovered. These plants were carefully taken up and carried to the Connecticut Experiment Station greenhouse in New Haven. One of

[1] *Zeitschrift für induktive Abstammungs- und Vererbungslehre*, Band 8, Heft 1 u. 2, 1912.

[2] *Amer. Nat.*, Vol. 46, 1912.

[3] *The Botanical Gazette*, Vol. 53, 1912.

the plants survived, and bore 72 leaves, blossoming about January 1. Considerable seed was saved from both the terminal and lateral inflorescence of this plant.

In 1913 about 5,000 plants were grown from this seed. These plants were true to the new type in all external characters, and differed from the normal Cuban in having a somewhat lighter green shade to the leaves, in an absence of basal suckers (lateral branches), and in a practically indeterminate growth, whereas the normal Cuban variety produces a terminal inflorescence after producing from 16 to 25 leaves on the main stem. Twenty plants were brought to our greenhouse in New Haven; all but eight, however, were injured during transportation. The eight uninjured plants commenced to blossom about the first of November, the range of leaf counts per plant being from 62 to 80, with the greater number around 70. These data show that this tobacco mutant is breeding true, and unless it behaves in a different manner from other mutants, it should breed true in succeeding generations.

The cured leaves are very promising, resembling the normal variety. There is every reason to believe that this new type will prove of commercial value, as the yield per acre is at least fifty per cent. greater than the normal type. It has been named the Stewart Cuban.

The normal Cuban seed which was saved in 1910 was again used for planting in 1913, and over 200 acres, or two and one half million plants, were grown. Although search was made at the Windsor Tobacco Growers' Corporation, which grows over 100 acres, no mutating plants were discovered. Two mutants were found at other plantations where the 1910 Windsor Corporation seed was used, which presented the same habit of producing a large leaf number. Thus, five similar mutants from the same seed have been discovered, though it can not be stated that they did not all come from a single normal plant. The frequency of the appearance of this mutation is at the rate of about one plant in a million.

This mutation must have taken place after fertilization, *i. e.*, after the union of the male and female reproductive cells. If the mutation had taken place in either the male or female cell before fertilization, the mutant would have been a first generation hybrid, and would have given a variable progeny the following season.

Mutations of high leaf number have been observed in tobacco previous to this time. Several years ago a variant with a large leaf number was found in the outdoor Havana type at the farm of Mr. Alsop in Avon, and in 1912 a Havana plant which bore 72 leaves was found at the Olds Brothers' Plantation in Bloomfield. Six similar mutations were found at a Windsor farm, and one at another farm in Bloomfield this last season. It is of interest to know that these mutations occurred in a variety, the Connecticut Havana, which has been grown in Connecticut for a period of over fifty years, and which is very uniform in habit. That it has been observed in different sections and by different growers shows that the same mutation must have taken place several times.

A similar type bearing a large leaf number appeared in Maryland several years ago, and is grown commercially under the name of Maryland Mammoth. The Maryland type was, however, the result of a cross between two Maryland tobacco varieties. The mutations which have occurred in Connecticut can hardly be explained on the basis of the results of a cross.

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REAL AND APPARENT NITRIFYING POWERS

IN making bacteriological studies of soils one of the leading factors determined is the ability of the bacteria present to convert various forms of nitrogen into the nitrate condition. Comparison of this ability, as existing in different soils, is usually made under definite, more or less standard conditions. This factor is spoken of as the "nitrifying power" or "nitrifying efficiency."

Of recent years the tendency has been to employ the soil to be tested, or a standard soil, as the medium in which the organisms

shall work. An additional supply of nitrogen is usually furnished, either in the form of ammonium-sulphate, or some highly nitrogenous, easily decomposed, organic substance, such as cottonseed meal or tankage. Where soil has been employed as the medium, one of three methods of procedure has usually been followed. One method is to add to a definite weight of soil a given amount of nitrogen, incubate and then determine the quantity of nitrate nitrogen present. The amount found, taking no account of the nitrate nitrogen originally present, is regarded as indicating the comparative ability of different soil samples to form nitrate nitrogen from other forms of nitrogen; in other words, its nitrifying power—ability—efficiency. A second method is to make a determination of the amount of nitrate nitrogen present in a corresponding sample at the beginning of the experiment; otherwise proceed as above. The difference between the amount originally present and that found at the final analysis is regarded as the correct factor. By a third method duplicate samples are taken and treated exactly alike with the exception that only one receives an additional supply of nitrogen. After incubation both are analyzed and the difference in the nitrate nitrogen content is regarded as the correct factor for comparison.

Recently, in determining what Stevens and Withers have termed the nitrifying inoculating power of a series of plots that are under study, it became necessary to use a soil relatively high in nitrate nitrogen. Cottonseed meal was employed as the source of nitrogen. In a large number of cases, securing the comparative factor by either of the last two mentioned methods, it was found to be a minus quantity. That is, with the conditions optimum (so far as is known) for nitrification, the amount of nitrate nitrogen found after incubating was much less than originally present in the soil. If ammonium sulphate were substituted for cottonseed meal, as the source of nitrogen, such a condition was never noted. This led to a series of investigations to determine the cause of the minus factors that were secured. There were evidently losses of large quantities of nitrate nitrogen. Was this due to actual losses of total nitrogen or was the nitrate nitrogen merely transformed? To what extent does it occur? What are the conditions influencing the same? These are some of the questions an effort is being made to answer. Certain grave difficulties have thus far prevented a complete solution of the problems involved. However, it is believed that in the near future sufficient data, together with that upon which the statements herein presented are made, will be secured to completely settle the question.

One very interesting fact has been brought to light. This is that at least two of the methods now employed in bacteriological laboratories for determining the relative nitrifying power of soils may give us absolutely no indication of true values. The writer has abundant evidence to show that this is true in the presence of appreciable quantities of nitrate nitrogen when easily decomposed organic substances are employed as the source of nitrogen. Oft-repeated observations show that where from five to twenty-five mg. of NO_3 per 100 gr. soil is present and cottonseed meal added, at the end of seven days absolutely no trace of NO_3 can be found. If examined three weeks later an abundance will be present. According to the last two methods mentioned above, the five to twenty-five mg. NO_3 would be subtracted from that found at the final analysis and the difference taken as the factor indicating the amount formed during incubation. In reality, the amount present reached zero at one time, hence all found at the final analysis must have been formed during incubation, and represents more nearly the correct factor.

In a series of experiments designed for the purpose of determining how much NO_3 would disappear it was found that in five days in the presence of .95 gr. cottonseed meal, as high as thirty-five mg. NO_3 per 100 gr. soil had been lost. With 1.9 gr. cottonseed meal the quantity ran up to fifty-five mg. With higher quantities of cottonseed meal still larger amounts of NO_3 were lost. With

small quantities of cottonseed meal the nitrate nitrogen may begin to accumulate again after ten days' incubation. With larger quantities the time is longer. This fact has probably caused many to overlook the first disappearance.

Just what becomes of the nitrate nitrogen, under such conditions, has not been determined. There are two possibilities. It may be liberated in the elementary form through the process of denitrification. This seems improbable since the soil in the writer's experiments has never been much over an inch in depth and never more than two thirds saturated, hence aeration was good. Another possibility is that it may be assimilated. There is always a very copious growth of soil fungi of various forms when cottonseed meal is applied. In fact, so abundant are the mycelial threads that they bind the soil together in a mass which is rather difficult to disintegrate by the ordinary shaking method. It is highly probable that at least a portion of the nitrate nitrogen is assimilated by this growth. It would seem that it would be very easy to determine the above question, but the volatilization of ammonia where large amounts are being formed, as is always the case in the presence of cottonseed meal, makes it difficult.

It is evident, from what has just been said, that deducting the nitrate nitrogen originally present or that in an incubated check, will not give us correct results under the conditions mentioned above. The more nitrate nitrogen initially present, the less reliable will be our results. These two methods must then be abandoned. Simply taking as the correct factor the amount found at the final analysis will probably approach nearer the truth than any other method now in practise. However, we have no assurance that this gives us an accurate idea of the relative amount formed in different soils. There is absolutely no way of determining the actual amount formed that immediately disappears. We only know that in this method the actual amount present at one time (unless very large amounts were initially present) was zero, and that all formed at any future date must have been formed during the course of the experiment.

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ON THE APPARENT ABSENCE OF APOGAMY IN ŒNOTHERA

IN a previous note in SCIENCE[1] I described certain experiments which suggested that *Œnothera* was occasionally apogamous. Three imperfect seeds were obtained from a castrated flower of *O.* mut. *lata,* suggesting the possibility that a small percentage of the seeds might develop apogamously. Last year (1912) the experiments were carried out more extensively, however, and the results were wholly negative, showing that if apogamy occurs in *O.* mut. *lata* it must be very rare indeed.

Six *lata* plants were experimented upon, whose history was as follows: one was a mutant appearing in a culture of a race of *O. Lamarckiana* from the Kolosvar Botanical Garden; two were derived from *lata* self-pollinated in the cultures of de Vries; two were mutants occurring in a *rubinervis*-like race obtained from Heribert-Nilsson in Sweden; and one was *O. biennis* mut. *lata* appearing in a race of *O. biennis* from the Madrid Botanical Garden. On these plants over 20 flowers were castrated and covered with bags during the height of the blooming season, from July 22 to August 13, 1912. In addition, a whole branch of one pollen-sterile *lata* plant, containing 20 flowers, was covered with a large bag. No growth of the capsules took place in any case, and not a single seed could be found in any of the capsules. It would appear, therefore, that under these circumstances at least, apogamous development practically never occurs in *lata,* for the number of ovules in the capsules observed must have numbered several thousands. The plants were, moreover, all well nourished.

Similar experiments made with eight flowers belonging to four plants of *O.* mut. *gigas* also

[1] Gates, R. R., "Apogamy in *Œnothera*," SCIENCE, N. S. 30: 691–694, 1909.

gave wholly negative results, not a single seed developing. This race of *gigas* came from an independent source, having originated, apparently by a mutation, in the Palermo Botanical Garden.[2] Theoretically, it might have been anticipated that the eggs of these plants, having already the diploid number of chromosomes (14) would be most likely to show a tendency to apogamy, but so far as the evidence goes this does not appear to be the case. The unbalanced chromosome number (15) in *lata* might on the other hand perhaps be expected to predispose megaspores or egg cells of *lata* having this number of chromosomes (assuming that such occur) instead of the reduced number, to degeneration.

Nevertheless, from the observation by Geerts of a megaspore mother cell of *Lamarckiana* containing 28 chromosomes, and from the discovery, by Miss Lutz[3] and Stomps,[4] of triploid mutants containing 21 chromosomes, it seems quite certain that eggs containing 14 chromosomes must occasionally be formed in *Lamarckiana*. Why such cells might not develop embryos occasionally, even if unfertilized, is not clear, and perhaps an extensive series of experiments with *Lamarckiana* and some of its 14-chromosome derivatives may yet show that this type of apogamy sometimes occurs.

In the light of these facts it appears desirable that the experiments of Mrs. Rose Haig-Thomas[5] on apogamy in *O. biennis* be repeated before the results are accepted as facts.

I may add that I have very recently observed a case of parthenocarpy in a race of *O. muricata* L. from eastern Canada grown in my cultures this season. This culture contained only four plants, all alike. Earlier in the season normal capsules were produced filled with seeds, but the later capsules (observed November 19) though full size and with normally developed walls, were hollow, containing undeveloped ovules instead of seeds. It seems possible that the drop in temperature at the end of the season may have been sufficient to kill the young embryos shortly after the eggs were fertilized, while the capsule walls, already stimulated by the process of fertilization, continued their development. However, nothing of the kind was observed in any other race.

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[2] Gates, R. R., "Tetraploid Mutants and Chromosome Mechanisms," *Biol. Centlbl.*, 33: 92–99, 113–150, Figs. 7, 1913.

[3] Lutz, Anne M., "Triploid Mutants in *Œnothera*," *Biol. Centlbl.*, 32: 385–435, Figs. 7, 1912.

[4] Stomps, Theo. J., "Mutation bei *Œnothera biennis* L.," *Biol. Centlbl.*, 32: 521–535, Pl. 1, Fig. 1, 1912.

[5] Haig-Thomas, Mrs. Rose, "Note sur la parthénogénèse chez les plantes," *Comptes Rendus*, IV• Conf. Intern. de Génétique, Paris, 1913, p. 209.

SOCIETIES AND ACADEMIES

THE AMERICAN PHILOSOPHICAL SOCIETY

On November 7, before the American Philosophical Society, a paper was read by Professor J. M. Macfarlane on "The Phylogeny of Plants in Relation to their Environment." Recalling the conclusions already published in the centennial volume of the Academy of Natural Sciences, the speaker showed that, of the simplest non-nucleate plants the great majority seem to have had a thermal-water or fresh-water origin. Of the simpler nucleate plants, such as the Desmids, the Protococcoid, Pleurococcoid, Chætophoroid, Cladophoroid and related groups, all or the prepondating number were fresh-water. Even the simplest brown algæ like *Lithoderma, Pleurocladia* and *Heribaudiella* were now in part or wholly fresh-water, as were the simplest groups of the red algæ. An estimation of the genera and species of algæ and fungi now living revealed that 3,008 genera and about 28,660 species were fresh-water or land forms, 658 genera and 5,930 species were marine. Interesting data were advanced as to transition or brackish species. The phylogenetic origin of bryophytic, pteridophytic and higher classes from certain fresh-water algæ was advocated, while the extreme rarity of any genus of these classes in marine surroundings was emphasized. The speaker, therefore, concluded that marine life was probably derived from a thermal-water and later from a fresh-water source. Though contrary to the whole trend of zoological consideration, he indicated that in an abstract already published he had advocated a like origin in fresh water for animal as for plant life, and a derived distribution of many groups of animals into the sea.